

REFERENCE



KING COUNTY, WASHINGTON SURFACE WATER DESIGN MANUAL

Note:

Although some of the materials in this Reference section may have been adopted by administrative rule or by ordinance, the administrative rule that adopted the Surface Water Design Manual has not formally adopted any of the materials in this section. All of the papers, forms, notes, equations, symbols, maps and other materials herein are for reference only.

King County assumes no responsibility for the completeness or current status of the materials contained in this section. It is the sole responsibility of each applicant to insure that the most current materials are used in preparing a permit application for their proposed project. Copies of these materials are available from DNRP or DLS-Permitting, or may be downloaded from the King County Water and Land Resources Division "Surface Water Design Manual Website."

1 KCC 9.04 – Surface Water Runoff Policy

2 Adopted Critical Drainage Areas

3 Other Adopted Area Specific Drainage Requirements

- A RA Zone Clearing Restrictions

4 Other Drainage Related Regulations and Guidelines

- A Grading Code Soil Amendment Standard
- B Clearing & Grading Seasonal Limitations
- C Landscape Management Plan Guidelines
- D Shared Facility Maintenance Responsibility Guidance

5 Wetland Hydrology Protection Guidelines

6 Hydrologic/Hydraulic Design Methods

- A Infiltration Rate Test Methods
- B Pond Geometry Equations
- C Introduction to Level Pool Routing
- D Supplemental Modeling Guidelines

7 Engineering Plan Support

- A King County Standard Map Symbols
- B Standard Plan Notes and Example Construction Sequence
- C Stormfilter Facility Access and Cartridge Configuration

8 Forms and Worksheets

- A Technical Information Report (TIR) Worksheet
- B Offsite Analysis Drainage System Table
- C Water Quality Facility Sizing Worksheets
- D Flow Control and Water Quality Facility Summary Sheet and Sketch
- E CSWPP Worksheet Forms
- F Adjustment Application Form and Process Guidelines
- G Dedication and Indemnification Clause - Final Recording
- H Bond Quantities Worksheet
- I Maintenance and Defect Agreement
- J Drainage Facility Covenant
- K Drainage Release Covenant
- L Drainage Easement
- M Flow Control BMP Covenant and BMP Maintenance Instructions (Recordable format)
- N Impervious Surface Limit Covenant
- O Clearing Limit Covenant
- P River Protection Easement
- Q Leachable Metals Covenant

9 Interim Changes to Requirements

- A Blanket Adjustments
- B Administrative Changes

10 King County-Identified Water Quality Problems

11 Materials

- A (VACANT)
- B (VACANT)
- C Bioretention Soil Media Standard Specifications
- D (VACANT)
- E Roofing Erodible or Leachable Materials

12 (VACANT)

13 (VACANT)

14 Supplemental Approved Facilities

- A Approved Proprietary Facilities
- B Approved Public Domain Facilities

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 1
SURFACE WATER RUNOFF POLICY

See King County Code, Section 9.04

http://www.kingcountv.gov/council/legislation/kc_code/12_Title_9.aspx

REFERENCE 2
ADOPTED CRITICAL DRAINAGE AREAS

(None at this time)

REFERENCE 3
OTHER ADOPTED AREA SPECIFIC DRAINAGE REQUIREMENTS

3-A RA ZONE CLEARING STANDARDS

See King County Code, Sections 16.82.150, 16.82.152, 16.82.154

http://www.kingcountv.gov/council/legislation/kc_code/19_Title_16.aspx

REFERENCE 4
OTHER DRAINAGE RELATED REGULATIONS AND GUIDELINES

4-A GRADING CODE SOIL AMENDMENT STANDARD

See King County Code, Section 16.82.100

http://www.kingcountv.gov/council/legislation/kc_code/19_Title_16.aspx

4-B CLEARING AND GRADING SEASONAL LIMITATIONS

See King County Code, Section 16.82.095

http://www.kingcountv.gov/council/legislation/kc_code/19_Title_16.aspx

4-C LANDSCAPE MANAGEMENT PLAN GUIDELINES

4-D SHARED FACILITY MAINTENANCE RESPONSIBILITY GUIDANCE

REFERENCE 4-C

LANDSCAPE MANAGEMENT PLAN GUIDELINES

Landscape management plans have the potential to significantly reduce the pollutant load washing off managed green spaces. For this reason, landscape management plans that incorporate key pollution prevention elements and which are consistently implemented can be used in lieu of water quality treatment facilities (see Section 1.2.8). These guidelines are intended to aid the preparation of comprehensive and effective landscape management plans. Submittal requirements for obtaining an approved landscape management plan are given in Chapter 2 and summarized below.

GENERAL CONSIDERATIONS

Studies of pollutant transport have consistently shown that forested lands consistently produce lower pollutant loads—of solids, phosphorus and metals—than do lands used for residential, industrial or agricultural purposes. “Loading” refers to the total weight of a pollutant leaving a particular area or site. It is measured by determining both the concentration of a pollutant and the amount of flow leaving a site. Since the Puget Sound area was largely forested before settlement, lakes and streams in the area have developed biotic regimes in response to this low pollutant loading—clear, cool waters supporting salmon and other aquatic life. When the input of pollutants increases, lakes and streams often shift to a more biologically productive mode, often with a concomitant loss of clear water and a shift or even a decline in fish species.

When forests are converted to cities, this increase in pollutant load needs to be managed in order to maintain the beneficial uses of lakes and streams. One way to manage pollutants is to treat stormwater before it enters a water body. Biofiltration swales, wetponds and sand filters, as well as other facilities, can be used to provide this treatment. Another approach to manage pollutant loads is to prevent the pollutants from entering stormwater in the first place.

Our best models on how to keep nutrients and pollutants from entering storm water are from the original, unaltered landscape—the forests. Forests have a soft, absorptive duff layer, as well as dense vegetative cover, especially near the ground surface. Nutrients are provided in the form of slow-release organic materials, or leaves, needles and woody material. Rainfall runoff is greatly reduced from the levels seen in developed landscapes. These factors help to keep the total load of nutrients and sediments transported to receiving waters low.

ELEMENTS OF A SUCCESSFUL LANDSCAPE MANAGEMENT PLAN

Good planning, tailored to the specific conditions of the site, as well as good follow-through, are both essential in controlling the pollutants generated when forests are replaced with lawns, gardens or other landscape features. This section will focus on planning. Follow-through, or implementation, will be discussed in the next section.

I. PLAN CONTENTS

A landscape management plan for any particular site works best if developed with the specific site characteristics in mind. Soil type, slope, exposure, depth to groundwater as well as the particular suite of plants chosen for the site all should help direct the specific make-up of the plan. However, there are some basic principles that all sites should consider in order to be successful in controlling the export of soil or organic matter, fertilizers and pesticides in stormwater runoff. Landscape management plans should address each of the following general principles, tailoring them to fit the specific site situation:

- 1) Minimize bare soil areas
- 2) Reduce water demand

- 3) Reduce extent of turf area—manage remaining turf for low-impact
- 4) Choose plants with sustainability in mind
- 5) Manage fertilizer and pesticide use wisely

Each of the five basic principles is expanded upon in the following section. The recommendations discussed under each principle are intended as a framework for a variety of site situations, from individual homes to large parks and golf courses. Thus, not every landscape management plan may be able to apply each of the listed recommendations. In addition, landscapes are managed for different purposes, some more formal than others. It may be that some recommendations will not be appropriate for very formal sites and thus not adopted, in favor of other management practices that better fit the uses for which the site is intended. In the end, the extent to which a landscape management plan is successful depends on the ability of the practices chosen to retain soil, fertilizers and pesticides on the site and away from water resources throughout the entire year.

Principle 1 Minimize bare soil areas

Bare soil areas are one source of solids that can be mobilized and carried downstream by rainfall. Minimizing bare soil areas makes it less likely that solid particles will be dislodged by rainfall. Some pointers on how to manage landscapes to minimize bare soil are given below.

- a) Establish dense plantings of pest-resistant groundcover to shade out weeds. Some easy-care recommendations are rock rose (*Cistus* sp.), snowberry (*Symphoricarpus alba*), salal (*Gaultheria shallon*) and kinnickinick (*Arctostaphylos uva-ursi*).
- b) If bare soil areas are required, as in plant beds or ball diamonds, surround the bare area with an area of grass or groundcover to filter out solids that may be picked up by stormwater runoff.
 - The denser the grass or groundcover, the better it works to capture solids in runoff.
 - Try to make the filtering area as level as possible. Avoid low spots, where runoff can concentrate and create channels.
 - In general, filter areas should be about one-fourth as long (along the flow path) as the area contributing low, assuming that slopes are gentle (less than about 10 percent). For flat, level areas without dips, this length can be reduced.
- c) Repair promptly bare patches in lawns or groundcovers that could contribute solids to stormwater runoff.
- d) Don't place bark or loose mulch on slopes where it can be carried to stormdrains.

Principle 2 Reduce water demand

Reducing the need for irrigation reduces the potential movement of pollutants, conserves water and saves money.

- a) Use drought tolerant or native vegetation.
- b) Install underground irrigation systems timed to water at night or drip irrigation systems.
- c) Increase the organic content of soils to improve water-retention capability.
- d) Allow for longer water retention by terracing sloped areas.

Principle 3 Reduce turf area and manage remaining turf for low-impact

Turf requires care to look good. In addition to mowing, turf areas typically require water, fertilizer and weed and disease control. However, some practices can reduce or minimize the amount of chemical controls needed.

- a) Amend soil with organic matter to a depth of 8 -12 inches before the lawn is established. Till the organic matter into the native soil.
- b) Decide if all lawn area needs the same level of upkeep: let some areas have a less formal look if possible, and reduce fertilizer and pesticide use in those areas.
- c) Rely on irrigation and lawn aeration as the primary tools to maintain healthy turf.
- d) Remove thatch each year to increase water penetration to grass roots and reduce runoff.
- e) Plant groundcovers rather than grass in shady areas. Turf grasses usually need at least partial sun to remain vigorous.

Principle 4 Choose plants with sustainability in mind

Plants differ in their ability to cope with different soils, rainfall conditions, pest and diseases and microclimates. Choosing resilient plant species, plants with adaptations for particular environments or creating optimal microenvironments are all techniques that can be used to create landscapes that require less intervention. Less watering and less need for pesticide and fertilizer application means less potential for pollutants to leave the site.

- a) Choose disease resistant plants.
- b) Choose drought-resistant groundcovers, shrubs and trees in areas with poor soil or little shading.
- c) Group plants in clusters with tree, shrub and groundcover layers to create a better micro-environment and to supply organic matter back to the soil.
- d) Include plants in the landscape that are important for beneficial insects such as parasitic wasps. If beneficial insects have nothing to sustain them, they won't stick around to control pests when you need them.
- e) Use dense plantings or close spacing to shade out weeds rather than herbicides.
- f) Use plants with fibrous roots on steeper slopes or erosion-prone areas.¹ Some good choices include:
 - *New Zealand flax (*Phormium tenax*)
 - Ornamental grasses, lawn grasses
 - *Rock rose (*Cistus* sp.)
 - *Rosa rugosa*
 - Salmonberry (*Rubus spectabilis*) -- native
 - Snowberry (*Symphoricarpos alba*)-- native
 - * not hardy in all areas of the County
- g) Use wetland plants in areas with seeps or a high water table.
- h) Attend to installation details. Write enforceable planting specifications that include details such as soil preparation, plant spacing, plant condition and size, planting depth, transplant handling and irrigation. Inspect the job during planting to prevent short cuts such as blowing the soil mixture around root balls rather than digging the roots into amended native soils.

¹ Note that the County's Sensitive Areas Code (21a) defines and protects steep slopes and landslide hazard areas from encroachment. Generally, clearing of vegetation is prohibited in areas with slopes of 40% or more.

Principle 5 Manage fertilizer and pesticide use wisely

Many landscape plants and turf simply won't do well without fertilization and some amount of pest management. It's therefore important for landscape management plans to address when and how these actions will be taken.

- a) Keep plants healthy by building healthy soil using composted organic material. Healthy plants can better resist diseases and insect pests.
- b) Tailor fertilizer make-up to lawn needs. Adjust application rate and timing of fertilizer applications to avoid carry-off in storm runoff.
- c) Reduce the phosphorus (P) concentration in fertilizers when possible by using a low phosphorous formulation or formulations containing only nitrogen or potassium. Added phosphorus is often not needed for health foliage growth, only for encouraging profuse blooms.
- d) Use an integrated pest management approach to control pests. Keep current about non-chemical controls as a first-defense against pests.
- e) Encourage a diverse insect community in your landscape: Beneficial insects can help control pests, especially pests of trees and shrubs.
- f) Target pesticide application to the specific pest of concern. Avoid pesticide "mixes" targeting generic problems (such as weed and feed) unless you actually need each of the formulations for a current problem.
- g) Only apply pesticides during the life-stage when the pest is vulnerable.
- h) Use fungicides very sparingly—they disrupt the base of aquatic food webs. If you need to use fungicides, spray formulations with faster break-down times. Consult a golf course management text for information on the attributes of various fungicides (and other pesticides). Balough and Walker, 1992, *Golf course management and construction* published by CRC Press is one source of information.
- i) Tolerate some weeds.

References

"Weed management for lawns and gardens." Washington Toxics Coalition Fact Sheet, 1989.

"Least toxic lawn management." The BioIntegral Resource Center (BIRC), P.O. Box 7414, Berkeley, CA 94707

Washington State Cooperative Extension publications on lawn care, Bulletin Office, Cooperative Extension, Cooper Publication Building, Washington State University, Pullman, WA 99164-5912

Selected titles include: "Turf grass diseases" and supplement (EB0713 and EB0713S); "European crane fly" (EB0856); "Fertilizer guide: western Washington" (FG0041); "Disease control in home lawns" (EB0938); "Home lawns" (EB0482).

II PLAN IMPLEMENTATION

A landscape management plan, no matter how good, will not reduce pollutants in runoff if it is not implemented. And implementation often means that the plan needs to be modified over time, since as plants grow and as the cycle of pests change, the original plan may not fit the site. The following must be addressed before a landscape management plan can be approved.

1. Identify who will be responsible for assuring the management plan is carried out.
2. Identify how the applicant will assure that grounds crews or homeowners have the training and/or resources required to implement the plan and keep up to date on advances in landscape care practices and products.

3. Agree to keep records of fertilizer and pesticide application, including rate of application, area treated and disposal or storage of residue.
4. Agree to certify each year that the landscape management plan for the project in question has been carried out, and that needed amendments or updates have been made.
5. Provide the plan to County maintenance or inspection personnel on request
6. Agree to pay an annual fee (based on time expended) to allow the County to administer the certification process, including review of plans, tracking of information, periodic field inspections and sampling.

III SUBMITTAL REQUIREMENTS (see SWDM Section 2.3.1.5)

To evaluate a Landscape Management Plan submittal, the following elements are required:

1. Provide a **site vicinity map** with topography.
2. Provide a **site plan** with topography. Indicate areas with saturated soils or high water tables.
3. Provide a **plant list** (provide both common and scientific names) that includes the following information:
 - a) Indicate any drought-tolerant plants, disease resistant varieties, species for attracting beneficial insects (if any) and native plants.
 - b) For shrubs and groundcovers, indicate the proposed spacing.
 - c) For turf areas, indicate the grass mix or mixes planned. Indicate sun/shade tolerance, disease susceptibility, drought tolerance and tolerance of wet soil conditions.
4. Provide a **landscape plan**. Indicate placement of landscape features, lawn areas, trees, and planting groups (forbes, herbs, groundcovers, etc.) on the **site**.
5. Include information on **soil preparation** and fertility requirements.
6. Provide information on the design of the **irrigation method** (installed sprinkler system, drip irrigation system, manual, etc.)
7. Provide a **landscape maintenance plan**, including the following:
 - a) Physical care methods, such as thatch removal or aeration, and mowing height and frequency
 - b) Type of fertilizer (including N-P-K strength) and fertilization schedule or criteria
 - c) Type of chemicals to be used for common pests such as crane fly larvae, and the criteria or schedule for application
 - d) Any biocontrol methods.
8. Provide information about the **storage of pesticides or other chemicals**, and **disposal measures** that will be used.
 - a) If applicable, indicate how the chemicals will be stored on the **site** between applications to prevent contact with stormwater or spills into the storm drainage system.
 - b) Indicate how excess quantities of fertilizers or chemicals will be handled for individual applications.
9. Provide an **implementation plan** (see Section II, Plan Implementation, above) for guidance on preparing the implementation plan).

REFERENCE 4-D

SHARED DRAINAGE FACILITY MAINTENANCE RESPONSIBILITY GUIDELINES

Shared facilities are flow control, conveyance, and/or water quality facilities designed and constructed in accordance with the provisions contained in the 2005 Surface Water Design Manual (SWDM) or later and which serve more than one project. By this we mean that the facility serves more than one residential subdivision, or may serve a combination of residential, commercial and public projects.

Shared facility policies are contained in the SWDM and K.C.C. 9.04.050. Core Requirement #6 states that "King County may assume maintenance of such facilities serving any mix of developments as part of a shared facilities plan."

Shared facilities must have a plan or agreement which is reviewed and approved by King County. The plan may be developed through the Master Drainage Plan process, or through the plat screening or commercial permit process. WLRD assists in the review of shared facility proposals within the existing support framework in the Adjustment and MDP programs, particularly regarding maintenance issues.

Guidelines for assigning maintenance responsibility

1. Shared facilities that serve only single-family residential projects (more than one subdivision) will be maintained by King County.
2. Shared facilities that serve a combination of residential and commercial projects where more than two-thirds of the developed contributing area served is a mix of single or duplex residential units on individual lots and any public improvements will be maintained by KC.
3. Shared facilities that serve a mix of single family residential, public, and commercial projects where a single commercial project is more than one third of the developed contributing area served will be maintained by the property owner of the single commercial project. The facilities must be located on the commercial property responsible for maintenance or within a tract or easement dedicated to the commercial property responsible for maintenance.
4. If there are two commercial projects which individually are more than one third of the developed contributing area served, the shared facility will be jointly maintained by the two commercial property owners. The facility must be located on one or both of the commercial properties responsible for maintenance or within a tract or easement dedicated to the commercial properties responsible for maintenance.
5. Shared facilities that serve commercial subdivision projects in which no single contributing parcel area is more than one third of the total contributing area served may be maintained by KC. The actual situation should be reviewed by WLRD as part of the shared facility plan review process to determine whether the facility should be maintained by KC.
6. King County may elect to maintain shared facilities where there are unusual circumstances such as where shared facilities are located off and not adjacent to the sites they serve.

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KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 5

WETLAND HYDROLOGY PROTECTION GUIDELINES

WA State Department of Ecology Wetland Protection
Requirements and Guidelines

- Appendix I-C.4 Wetland Hydroperiod Protection
 - Appendix I-C.5 Wetland Hydroperiod Data Collection
and Evaluation Procedures
 - Appendix I-C.8 Wetland Protection Definitions
-

REFERENCE 5

WETLAND HYDROLOGY PROTECTION GUIDELINES

This Reference is excerpted from the Washington State Department of Ecology's 2019 Stormwater Management Manual for Western Washington (SMMWW), with modifications where necessary to refer to King County Surface Water Design Manual (SWDM) sections and terminology. "Flow Control BMPs" in the following text refer to what are termed "flow control facilities" in the SWDM.

I-C.4 Wetland Hydroperiod Protection

Protection of many wetland functions and values depends on maintaining the existing wetland's hydroperiod. This means maintaining the annual fluctuations in water depth and its timing as closely as possible. If a project or threshold discharge area within a project discharging to a wetland require a flow control facility per Core Requirement # 3 of the SWDM, the project must apply the following Wetland Hydroperiod Protection.

The Wetland Hydroperiod Protection is separated into two methods (Methods 1 and 2) that are dependent on the wetland category, and whether the project proponent has legal access to the wetland.

The first method requires a minimum one year of monitoring followed by continuous simulation modeling of the wetland stage (called Method 1). Method 1 shall be applied to the wetlands listed below.

- Category I or II depressional or riverine impounding (including special characteristics Category I or II) wetlands that the project proponent owns, or the project proponent has legal access to – for purposes of conducting monitoring in the wetland.

Method 1 takes into account wetland specific information and field data, therefore, it allows more detailed evaluation of effects of stormwater on wetland functions. In cases where the project proponent neither owns nor has legal access to the Category I or II wetlands receiving stormwater from a proposed project, Method 2 shall be used.

Method 2 uses a site discharge volume model to evaluate hydrologic changes in a wetland, with no additional wetland monitoring requirement. Method 2 shall be applied to the wetlands listed below.

- Category I or II wetlands that are off-site or the project proponent doesn't have legal access to conduct monitoring in the wetland,
- Category I or II riverine, slope or lake-fringe wetlands,
- Category III and IV wetlands with habitat score greater than 5,
- Category III or IV interdunal special characteristic wetlands,
- Category III and IV wetlands that provide habitat for rare, threatened, endangered or sensitive species,
- Category III and IV wetlands that contain a breeding population of any native amphibian species.

- If the wetland has permanent or seasonal ponding or inundation, assume that it has a breeding population of native amphibians.
- For seasonal ponding, if the wetland has surface ponding after May 1 of a normal water year or drier, assume that it has a breeding population of native amphibians.
- See the Wetland Rating System for guidance on identifying field indicators.
- Recent aerial images of surface water in the wetland during normal water year or drier year can also indicate presence of permanent or seasonal ponding.

Method 1: 1-yr Wetland Monitoring and Wetland Stage Modeling

Method 1 criteria and analysis is based on the presumption that a wetland has limited water level fluctuation and water holding capacity. The risk to the wetland will be minimal if the frequency and duration of water level fluctuation (WLF) in the wetland and the WLF timing post project remain as similar to pre-project levels as possible. Therefore, the criteria sets limits on the frequency and duration of stage excursions (greater WLF than the pre-project level), as well as on overall WLF after development. The criteria were developed based on studies in *Wetlands and Urbanization, Implications for the Future* (Azous and Horner, 1997)ⁱⁱ.

One water year of field monitoring will characterize the existing WLF and water holding capacity of the wetland, and it will be used to calculate the allowable WLF by the proposed development.

A hydrologic assessment to measure or estimate elements of the hydroperiod under pre-project and post-project conditions should be performed with the aid of a qualified scientist or wetland specialist.

Criteria for Method 1

The project proponent must meet the following six Method 1 criteria in order to comply with the Wetland Hydroperiod Protection requirements.

Criteria 1. Mean Monthly WLF Limit

- If the pre-project (monitored) mean monthly WLF for a given calendar month is < 15cm (0.49ft, 5.91inch), the post-project mean WLF of the wetland for that calendar month may increase to no more than 20 cm (0.66ft, 7.87inch).
- If the pre-project (monitored) mean monthly WLF for a given calendar month is ≥ 15 cm (0.49ft, 5.91inch), the post-project mean monthly WLF of the wetland for that calendar month may increase by up to, but no more than, 5 cm (0.16ft, 1.97inch).
- Without one year of monitoring data, assume the pre-project mean monthly WLF for any month is ≥ 15 cm (0.49ft, 5.91inch), and the post-project mean monthly WLF of the wetland for that calendar month may increase by up to, but no more than, 5 cm (0.16ft, 1.97inch).

Criteria 2. Mean Annual WLF Limit

- If the pre-project (monitored) mean annual WLF is < 15cm (0.49ft), the post-project mean annual WLF of the wetland may increase to no more than 20 cm (0.66ft, 7.87inch).

- If the pre-project (monitored) mean annual WLF is ≥ 15 cm (0.49ft, 5.91inch), the post-project mean annual WLF of the wetland may increase by up to, but no more than, 5 cm (0.16ft, 1.97inch).
- Without one year of monitoring data, assume the pre-project mean annual WLF is ≥ 15 cm (0.49ft, 5.91inch), and the post-project mean annual WLF of the wetland may increase by up to, but no more than, 5 cm (0.16ft, 1.97inch)

Criteria 3. Frequency of Stage Excursions

- The frequency of stage excursions of 15 cm (0.49ft, 5.91inch) above or below the pre-project stage must not exceed an annual average of six.

Criteria 4. Durations of Stage Excursions

- The duration of stage excursions of 15 cm (0.49ft, 5.91inch) above or below the pre-project stage must not exceed 3 days per excursion.

AND

- *For a Wetland that Provides Habitat for Native Amphibians:* The stage excursions above or below the pre-project stage must not exceed 8 cm (0.26ft, 3.15inch) for more than 1 day in any 30-day period between January 1 and May 31. The hydroperiod limits characterize wetlands inhabited by breeding native amphibians and apply to breeding zones during the period of January 1 through May 31. If these limits are exceeded, then amphibian breeding success is likely to decline.

OR

- *For a Peat Wetland:* The duration of stage excursions in the post-project scenario cannot be above the pre-project stage for more than 1 day in any year, and applies to all zones over the entire year. If this limit is exceeded, then characteristic bog or fen wetland vegetation is likely to decline.

Criteria 5. Total Dry Period Change

- The total dry period (when pools dry down to the soil surface everywhere in the wetland) must not increase or decrease by more than two weeks in any year between the pre-project and post-project scenarios.

Criteria 6. Perennial to Ephemeral or Seasonal Avoidance

- Alterations to watershed and wetland hydrology that may cause perennial wetlands to become ephemeral or seasonal post-project must be avoided.
- If modeled wetland stage indicates that the wetland is perennial, the dry period at the post-project scenario should not exceed 1 day in any year.

Additional guidance, as well as an Excel template to assist with the calculations to verify compliance with Method 1 is provided in **I-C.5 Wetland Hydroperiod Data Collection and Evaluation Procedures**.

Method 2: Site Discharge Modeling

An alternative way to predict the risk to the wetland hydroperiod from stormwater discharges is to assess the changes in total volume of flows into a wetland that result from the development

project. The size of the wetland and its capacity are not known or needed to utilize Method 2. The risk to wetland functions will be assumed to increase as the total discharge volumes from the site into the wetland diverge from the pre-project conditions. The risk will be decreased if the divergence is smaller.

As stormwater generated at the project site passes through the wetland buffer, total discharge volumes from the site to the wetland are to be calculated at the outflow of the wetland buffer. The existing or required length and area of wetland buffer per local and/or state regulations around the wetland should be included as an element in the model under both pre-project (existing) and post-project scenarios.

Criteria for Method 2

The project proponent must ensure they are meeting both of the following Method 2 criteria in order to comply with Wetland Hydroperiod Protection.

Criteria 1. Mean Daily Total Discharge Volumes from the Site

Total volume of water into a wetland on daily basis should not be more than 20% higher or lower than the pre-project volumes.

- Calculate the average of the total discharge volumes from the site for each day over the period of precipitation record in the approved model for pre- and post-project scenarios. There will be 365 (366 for a leap year) average daily values for the pre-project scenario and 365 (366 for a leap year) for the post-project. No day can exceed 20% change in volume.

Criteria 2. Mean Monthly Total Discharge Volumes from the Site

Total volume of water into a wetland on a monthly basis should not be more than 15% higher or lower than the pre-project volumes.

- Calculate the average of the monthly total discharge volumes from the site for each calendar month over the period of precipitation record in the approved model for pre- and post-project scenarios. No month can exceed 15% change in volume.

The guidance for implementing Method 2 and assessing the criteria above in the respective model is provided in section **I-C.5 Wetland Hydroperiod Data Collection and Evaluation Procedures**.

Limitations

Method 2 may not result in complete protection of wetland functions and values as these criteria are based on risk to the resource rather than an actual understanding of the impacts. When applicable, Ecology recommends application of the Wetland Hydroperiod Protection with wetland-specific monitoring as described in Method 1.

I-C.5 Wetland Hydroperiod Data Collection and Evaluation Procedures

Method 1

Field Monitoring and Data Collection

Field monitoring data of the wetland must be collected to determine the existing pre-project hydroperiod, which will then be compared to model outputs to verify compliance with the Hydroperiod Protection Criteria. Without one year of hydroperiod monitoring, the minimum allowable WLF change can be used (see **Criteria for Method 1** in **I-C.4 Wetland Hydroperiod Protection** and **Steps to Verify Compliance with the Method 1 Hydroperiod Protection Criteria** below).

An Ecology approved continuous simulation model will be needed for data analysis. Relevant historic monitoring information can also inform the pre-project condition of the wetland. The following lists describe the minimum required wetland specific information in order to implement the Method 1 Wetland Hydroperiod Protection guidance.

1. Contour Data or Water Storage Capacity

Bathymetry, or wetland contours, is indicative of the water storage capacity of the wetland that will be used in the model simulation.

If possible, the bathymetry of the wetland should be surveyed. LIDAR data or GIS analysis may also be used to provide approximate wetland contours.

In the absence of bathymetry data, approximate the bathymetry using the permanent ponding area and assume that the storage will occur on top of that area. This resulting storage area will be lower than the actual area, providing a more protective model.

2. Hydroperiod Monitoring

Collect at least one year of water levels (instantaneous water stage and crest stage) using a crest stage gage or continuous water level loggers in the wetland. Water levels should be collected at least monthly over a year.

Average base stage = (Instantaneous stage at the beginning of interval + Instantaneous stage at the end of interval)/2

3. Flow Monitoring

The goal of this monitoring is to construct a relationship in the model to simulate how flows will be released from the wetland for each given stage. A simplified monitoring approach may be appropriate for a simple wetland flow regime. For instance, where a well-defined outlet controls the outflows from a wetland, instantaneous monitoring of the outflow for the typical range of flows may be sufficient. In this simple case, a velocity and cross-section and stage monitoring at the outlet can be sufficient to create the relationship for the model. These measurements may be performed in conjunction with the hydroperiod monitoring described above. Additional field

visits timed with precipitation or dry periods may be necessary to ensure that the outflow relationship covers the range of modeled flows.

Ecology acknowledges that it can be challenging to determine the location(s) of flows to and from wetlands. In some cases, there will be a clear channel that is the source of the inflows and outflows, while in others, the water may disperse over a wide area. An alternative would be to gather nearly continuous (every 15 minute) rainfall data along with wetland stage data (hydroperiod monitoring) and adjust the storage and discharge rate within the model using these data. If the flow data or estimation in the model are not available, assume there is no surface outflow for the wetland (closed depression).

Chapter 8 of *Wetlands and Urbanization, Implications for the Future* (Azous and Horner, 1997)ⁱⁱ indicates that a complete wetland water balance includes precipitation, evapotranspiration, surface inflow, surface outflow, groundwater exchange, and change in wetland storage using a tipping-bucket gage and continuous flow measurements. The wetland assessment as part of this Method 1 needs to consider the more protective approach to develop that relationship. A scientist (e.g. wetland scientist or hydrologist) may determine that the groundwater flow is a significant characteristic of the outflow of the system. In this case the project proponent may need to determine the groundwater regime of the system.

Model Construction and Simulation

The project proponent should develop a stage-storage-discharge (SSD) table that represents the volume of water that ponds in the wetland and the flow rate of water that discharges from the wetland at a given stage.

Having a reliable SSD table that represents the wetland is essential to evaluate the effects of development in the model. Wetland bathymetry and contour data by field measurement or using equations to represent the volume-area-depth relations of wetlands and wetland flow monitoring data are critical to develop the SSD table for the wetland.

In the absence of actual wetland flow monitoring data, it may be possible to develop a SSD table for the wetland by combining the model simulated flows with the field data obtained on the wetland WLF (hydroperiod monitoring) data. This would require an iterative modeling process. The modeling iterations would involve manually changing the discharge rates in the SSD table until the resulting simulated WLF approach WLF from the field monitoring data. The project proponent or modeler should provide the details of how this estimated in its hydrologic assessment report, so that it can be reviewed by the local jurisdiction.

With an SSD table, the following are necessary for the model simulation to evaluate the discharge of development in the model and determine compliance with the Method 1 Wetland Hydroperiod Protection criteria.

- Pre-project condition land uses and associated acreage for the entire contributing area that drains to the wetland.
- Post-project condition land uses and associated acreage for the entire contributing area that drains to the wetland.

- Percentage of developing project area compared to total acreage of contributing area that drains to the wetland.

Pre-Project Simulation

1. Identify existing impervious and pervious surfaces that discharge to the wetland and use the model elements to represent the land use and associated acreage for all hydrologically contributing areas to the wetland.
2. Add the wetland buffer using the lateral flow soil basin, or include it as part of the contributing area land use.
3. Connect the runoff from the contributing basin(s) including interflow and groundwater to the SSD table that represents the wetland.
4. Set the outflow of the wetland as the Point of Compliance (POC).

Post-Project Simulation

1. Identify anticipated impervious and pervious surfaces that discharge to the wetland and use the model elements to represent the land use and associated acreage for all hydrologically contributing areas to the wetland.
2. Identify any Flow Control BMPs in the contributing area draining to the wetland and use the appropriate model elements to represent these facilities.
3. Add the wetland buffer using the lateral flow soil basin, or include it as part of the contributing area land use.
4. Connect the runoff from the contributing basin(s) (including the buffer) including interflow and groundwater to the same SSD table that was used in the pre-project scenario.
5. Connect flows from any Flow Control BMP elements through the downstream element(s) to SSD table that represents the wetland.
6. Connect any infiltration from Flow Control BMP elements to groundwater of SSD table (if applicable).
7. Set the outflow of the wetland as the POC.

The order of the steps above depends on the type of elements and their intended function and could change to be more representative of the contributing flow pathways to the wetland.

Once the model simulations are done for post and pre-project scenarios, export the SSD table stage data for the full period of record: daily, monthly and yearly average, and Max and Min stage.

These model outputs, together with monitored WLF, are to be used to verify compliance with the Method 1 Hydroperiod Protection Criteria in **I-C.4 Wetland Hydroperiod Protection**.

Steps to Verify Compliance with the Method 1 Hydroperiod Protection Criteria

Ecology has provided an Excel template to assist with the calculations in the steps below. The Excel template may be downloaded from the interactive online version of the 2019 Stormwater Management Manual for Western Washington

1) Calculate the Existing WLF of Wetland using Monitored Water Levels

Using the measurements of crest and instantaneous stage during a series of time intervals over a year, calculate water level fluctuation (WLF) between measurements.

Calculate mean annual and mean monthly WLF as the arithmetic averages of a year and each month for which data are available.

$$\text{Water level fluctuation (WLF)} = \text{Crest stage} - \text{Average base stage}$$

2) Estimate the WLF by Continuous Simulation of Stages in the Model

Using modeled daily, monthly and yearly stages (average, max and min) for the full period of record, calculate daily, monthly or annual WLF as follows:

$$\text{WLF} = \text{Max stage} - \text{average stage}$$

3) Calculate Allowable WLF change

Allowable WLF change by the proposed project is determined by two factors: Monitored WLF of the wetland, and the size of the proposed project relative to the wetland's contributing basin area.

Allowable WLF change for the proposed project is calculated as follows:

- If monitored WLF is < 15 cm (0.49 ft, 5.91 inch),
 - Allowable WLF change for the wetland (A) = 20 cm (0.66 ft, 7.87 inch) – monitored WLF
 - **Allowable WLF change for the proposed project** = A / percentage of development by proposed project in the contributing basin area.
- If monitored WLF for a given calendar month is ≥ 15 cm (0.49 ft, 5.91 inch),
 - Allowable WLF of the wetland (A) for that calendar month may increase by up to, but no more than, 5 cm (0.16 ft, 1.97 inch).
 - **Allowable WLF change for the proposed project** = 5 cm / percentage of development by proposed project in the contributing basin area.

For example, if the project develops 10 acres of a 100 acre basin (10 %), the project can cause no more than 10 % of total allowable WLF change in the wetland. If the total allowable WLF change for the wetland is 10 cm (0.32 ft, 3.94 inch), the allowable WLF change for the proposed site is 1.0 cm (0.032 ft, 0.394 inch).

4) Verify Compliance with the Criteria

Compare each modeled daily, monthly or annual WLF with the calculated allowable WLF (factored by percentage of development by proposed project in the contributing basin area). If any of the modeled WLF difference between pre-project and post-project scenarios exceeds the calculated allowable WLF change for the proposed project, it means the proposed project does not comply with Method 1 Wetland Hydroperiod Protection.

For criteria about durations and frequencies, assess individual modeled stage outputs to verify compliance.

Method 2

Model Construction and Simulation

When modeling, include the wetland buffer as the final element in both pre- and post-project scenarios, downstream of the project area including any Flow Control BMPs. The point of compliance (POC) should be assigned to capture the total (surface, interflow, and ground water) volume leaving the wetland buffer for both the pre-project and the post-project scenarios.

Pre-project simulation

1. Identify existing impervious and pervious surfaces that discharge to the wetland and use the model elements to represent these land areas.
2. Identify the wetland buffer area and use the lateral flow soil basin to represent the wetland buffer.
3. Connect the model elements to the wetland buffer ensuring that impervious land areas are connected to surface flows and that for any other model elements all flows (surface, interflow, and ground water) are connected.
4. Set the wetland buffer element as the most downstream element.
5. Set the POC at the outflow of the wetland buffer element including surface runoff, interflow, and ground water.

Post-project simulation

1. Identify anticipated post-project impervious and pervious surfaces that discharge to the wetland and use the model elements to represent these land areas.
2. Identify any Flow Control BMPs and use the appropriate the model elements to represent these facilities.
3. Identify the wetland buffer area and use the lateral flow soil basin to represent the wetland buffer.
4. Connect the model elements to the wetland buffer ensuring that impervious land areas are connected to surface flows and that for any other model elements all flows (surface, interflow, and ground water) are connected.
5. Connect any Flow Control BMP elements to the wetland buffer ensuring that surface flows are connected to surface water and any infiltration is connected to ground water.
6. Set the wetland buffer element as the most downstream element.
7. Set the POC at the outflow of the wetland buffer element including surface runoff, interflow, and ground water.

Once the model simulations are done for post and pre-project scenarios, verify compliance with the Method 2 Hydroperiod Protection Criteria.

Strategies to meet the Wetland Hydroperiod Protection Criteria

Consider the following strategies to minimize impacts on the wetland hydroperiod and to meet the criteria. The list is in order of preference:

- Increasing the retention of natural pervious cover.
- Reducing the level of development.
- Reducing the total amount of impervious surfaces.
- Increasing infiltration using on-site LID techniques.
- Increasing or maintaining larger wetland buffer zones.
- Increasing infiltration and/or storage capacity of Flow Control BMPs.

I-C.8 Wetland Protection Definitions

The following terms are applicable only to this Appendix.

Buffer

The area (either upland, open water, or another wetland) that surrounds a wetland or watercourse and that reduces adverse impacts to the ecosystem functions and values from adjacent development.

Hydroperiod

The seasonal occurrence of flooding and/or soil saturation; it encompasses the depth, frequency, duration, and seasonal pattern of inundation.

Peat Wetland

Unique, irreplaceable bogs and fens that can exhibit water pH in a wide range from highly acidic to alkaline, including fens typified by *Sphagnum* species, *Rhododendron groenlandicum* (Labrador tea), *Drosera rotundifolia* (sundew), and *Vaccinium oxycoccos* (bog cranberry); marl fens; estuarine peat deposits; and other moss peat systems with relatively diverse, undisturbed flora and fauna. Bog is the common name for peat systems having the *Sphagnum* association described, but this term applies strictly only to systems that receive water income from precipitation exclusively.

Perennial Wetland

Wetlands where at least a portion of their area has permanent surface water (i.e., flooded or inundated throughout the year), in a normal water year or wetter.

POC

Point of compliance

Riverine impounding wetland

Riverine impounded wetlands retain surface water significantly longer than the duration of the flood event. Riverine impounded wetlands tend to hold water for more than a week after a flood event. These wetlands are found in a topographic depression on the valley floor, or in areas where natural or human made barriers to downstream flow occur.

Seasonal wetland, Seasonal ponding

A wetland that has water above the soil surface for a period of time (usually between two months to less than one year) during and/or after the wettest season but in typical years dries to or below the soil surface in warmer, drier weather.

SSD

stage-storage-discharge

Stage excursion

A post-project departure, either higher or lower, from the water depth existing under a given set of conditions in the pre-development state.

Water Level Fluctuation (WLF)

This is a defining characteristic of a wetland. Water level fluctuation (WLF) during a monitoring interval is as follows:

Average base stage = (Instantaneous stage at beginning of interval + Instantaneous stage at end of interval)/2

Wetland functions

The ecological (physical, chemical, and biological) processes or attributes of a wetland. Functions are often defined in terms of the processes that provide value to society, but they can also be defined based on processes that are not value based. Wetland functions include food chain support, provision of ecosystem diversity and fish and wildlife habitat, flood flow alteration, ground water recharge and discharge, water quality improvement, and soil stabilization.

Wetlands

Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from nonwetland areas to mitigate the conversion of wetlands. (Waterbodies not included in the definition of wetlands as well as those mentioned in the definition are still waters of the state.)

WLF

See **Water Level Fluctuation** definition

References

ⁱⁱ Amanda L. Azous and Richard R. Horner (eds.), *Wetlands and Urbanization, Implications for the Future*, Final Report of the Puget Sound Wetlands and Stormwater Management Research Program, 1997. (vi)

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 6
HYDROLOGIC/HYDRAULIC
DESIGN METHODS

- 6-A Infiltration Rate Test Methods
- 6-B Pond Geometry Equations
- 6-C Introduction to Level Pool Routing
- 6-D Supplemental Modeling Guidelines

REFERENCE 6-A

INFILTRATION RATE TEST METHODS

See SWDM Chapter 5 and Appendix C for applications and limitations for the use of the infiltration rate test methods below.

PILOT INFILTRATION TEST (PIT)

Source: Stormwater Management Manual for Western Washington (SMMWW 2014)

In-situ infiltration measurements using the Pilot Infiltration Test (PIT) described below is the preferred method for estimating the measured (initial) saturated hydraulic conductivity (K_{sat}) of the soil profile beneath the proposed infiltration facility. The larger PIT reduces some of the scale errors associated with relatively small-scale double ring infiltrometer or “stove-pipe” infiltration tests. It is not a standard test but rather a practical field procedure recommended by Ecology’s Technical Advisory Committee.

LARGE-SCALE PILOT INFILTRATION TEST (PIT)

Infiltration Test

- Excavate the test pit to the estimated surface elevation of the proposed infiltration facility. Lay back the slopes sufficiently to avoid caving and erosion during the test. Alternatively, consider shoring the sides of the test pit.
- The horizontal surface area of the bottom of the test pit should be approximately 100 square feet. Accurately document the size and geometry of the test pit.
- Install a vertical measuring rod (minimum 5-ft. long) marked in half-inch increments in the center of the pit bottom.
- Use a rigid 6-inch diameter pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the pond bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates.
- Add water to the pit at a rate that will maintain a water level between 6 and 12 inches above the bottom of the pit. A rotameter can be used to measure the flow rate into the pit.

Note: The depth should not exceed the proposed maximum depth of water expected in the completed facility. For infiltration facilities serving large drainage areas, designs with multiple feet of standing water can have infiltration tests with greater than 1 foot of standing water.

Every 15-30 min, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point on the measuring rod.

Keep adding water to the pit until one hour after the flow rate into the pit has stabilized (constant flow rate; a goal of 5% variation or less variation in the total flow) while maintaining the same pond water level. The total of the pre-soak time plus one hour after the flow rate has stabilized should be no less than 6 hours.

- After the flow rate has stabilized for at least one hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty. Consider running this falling head phase of the test several times to estimate the dependency of infiltration rate with head.

- At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to hydraulic restricting layer, and is determined by the engineer or certified soils professional. Mounding is an indication that a mounding analysis is necessary.

Data Analysis

Calculate and record the saturated hydraulic conductivity rate in inches per hour in 30 minutes or one-hour increments until one hour after the flow has stabilized.

Note: Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes. This would be the lowest hourly flow rate.

Apply appropriate correction factors to determine the site-specific design infiltration rate. See the discussion of correction factors for infiltration facilities in KCSWDM Section 5.2.1.

Example

The area of the bottom of the test pit is 8.5-ft. by 11.5-ft.

Water flow rate was measured and recorded at intervals ranging from 15 to 30 minutes throughout the test. Between 400 minutes and 1,000 minutes the flow rate stabilized between 10 and 12.5 gallons per minute or 600 to 750 gallons per hour, or an average of $(9.8 + 12.3) / 2 = 11.1$ inches per hour.

SMALL-SCALE PILOT INFILTRATION TEST (PIT)

A smaller-scale PIT can be substituted for the large-scale PIT in any of the following instances.

- The drainage area to the infiltration site is less than 1 acre.
- The testing is for LID BMP's that serve small drainage areas and /or are widely dispersed throughout a project site.
- The site has a high infiltration rate, making a large-scale PIT difficult, and the site geotechnical investigation suggests uniform subsurface characteristics.

Infiltration Test

- Excavate the test pit to the estimated surface elevation of the proposed infiltration facility. In the case of bioretention, excavate to the estimated elevation at which the imported soil mix will lie on top of the underlying native soil. For trenches, excavate to the proposed bottom of the trench. For permeable pavements, excavate to the elevation at which the imported subgrade materials, or the pavement itself, will contact the underlying native soil. If the native soils (road subgrade) will have to meet a minimum subgrade compaction requirement, compact the native soil to that requirement prior to testing. Note that the permeable pavement design guidance recommends compaction not exceed 90% - 92%. Finally, lay back the slopes sufficiently to avoid caving and erosion during the test. Alternatively, consider shoring the sides of the test pit.
- The horizontal surface area of the bottom of the test pit should be 12 to 32 square feet. It may be circular or rectangular, but accurately document the size and geometry of the test pit.
- Install a vertical measuring rod adequate to measure the ponded water depth and that is marked in half-inch increments in the center of the pit bottom.
- Use a rigid pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the pond bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates. Use a 3-inch diameter pipe for pits on the smaller end of the recommended surface area, and a 4-inch pipe for pits on the larger end of the recommended surface area.

- Pre-soak period: Add water to the pit so that there is standing water for at least 6 hours. Maintain the pre-soak water level at least 12 inches above the bottom of the pit.
- At the end of the pre-soak period, add water to the pit at a rate that will maintain a 6-12 inch water level above the bottom of the pit over a full hour. The depth should not exceed the proposed maximum depth of water expected in the completed facility.
- Every 15 minutes, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point (between 6 inches and 1 foot) on the measuring rod. The specific depth should be the same as the maximum designed ponding depth (usually 6 – 12 inches).
- After one hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty.
- A self-logging pressure sensor may also be used to determine water depth and drain-down.
- At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to hydraulic restricting layer, and is determined by the engineer or certified soils professional. The soils professional should judge whether a mounding analysis is necessary.

Data Analysis

See the explanation above under the guidance for the large-scale pilot infiltration test.

SINGLE-RING PERCOLATION TEST PROCEDURE

(See SWDM Section 5.2 and Appendix C for limitations on the use of this procedure)

Preparation for Test

A single ring made of steel or other durable material a minimum of 3 feet in diameter and a minimum of 6 inches high and an adequate supply of clear water is needed. Tests must be performed in undisturbed native soil in suitable locations to determine soil percolation rates for the proposed infiltration facility. The surface of the soil where the test is to be run must be accurately leveled and the ring imbedded and sealed in the soil to prevent water from running under the ring and onto the surface.

Soaking Period

The ring shall be carefully filled with at least 6 inches of clear water. The depth of water should be maintained for at least 4 hours and preferably overnight if fine-grained soils are present. Automatic siphons or float valves may be employed to automatically maintain the water level during the soaking period. It is extremely important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained.

In sandy soils with little or no fines, soaking is not necessary. If, after filling the ring twice with 6 inches of water, the water seeps completely away in less than ten minutes, the test can proceed immediately.

Measurement of the Percolation Rate

Except for sandy soils, percolation rate measurements are made 15 hours but no more than 30 hours after the soaking period began. The water level is adjusted to 6 inches above the soil surface and successive measurements are taken to determine the percolation rate. At no time during the test is the water level allowed to rise more than 6 inches above the soil surface.

Immediately after adjustment, the water level is measured from a fixed reference point to the nearest 1/16th inch at 30-minute intervals. The test is continued until two successive water level drops do not vary by more than 1/16 inch within a 90-minute period. After each measurement, the water level is readjusted to the 6-inch level. The last water level drop is used to calculate the percolation rate.

In sandy soils or soils in which the first 6-inch of water added after the soaking period seeps away in less than 30 minutes, water level measurements are made at 10-minute intervals for a 1-hour period. The last water level drop is used to calculate the percolation rate.

Calculation of the Percolation Rate

The percolation rate is calculated for each test by dividing the time interval used between measurements by the magnitude of the last water level drop. This calculation results in a percolation rate in terms of minutes/inch. To determine the percolation rate for the area, the rates obtained from each hole are averaged.

Example: If the last measured drop in water level after 30 minutes is 5/8-inch, then:

$$\text{Percolation rate} = (30 \text{ minutes}) / (5/8 \text{ inch}) = 48 \text{ minutes/inch.}$$

REFERENCE 6-B

POND GEOMETRY CALCULATIONS

<Known>

Volume	(V)
Pond Depth	(D)
Side Slope	(S _s)
Length-to-Width Ratio	(R)

<Find>

Bottom Area of Rectangular Pond, A_o

<Solution>

Y = depth of section measured from bottom, from zero to D

W_o = width at pond bottom

The pond width (W) at any depth, Y:

$$W_Y = W_o + 2S_s Y \quad (\text{Eq. 1})$$

The pond length (L) at any depth, Y:

$$L_Y = RW_o + 2S_s Y \quad (\text{Eq. 2})$$

The pond area at any depth, Y:

$$A_Y = L_Y W_Y = (RW_o + 2S_s Y)(W_o + 2S_s Y) \quad (\text{Eq. 3})$$

or,

$$A_Y = RW_o^2 + (R+1)2W_o S_s Y + 4S_s^2 Y^2 \quad (\text{Eq. 4})$$

The equation for the pond-full volume (V) is obtained by integrating between Y=0 and Y=D:

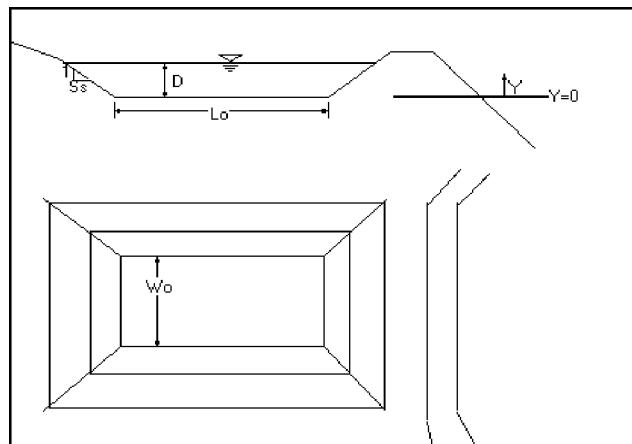
$$V = \int_0^D (RW_o^2 + (R+1)2W_o S_s Y + 4S_s^2 Y^2) dY \quad (\text{Eq. 5})$$

or,

$$V = \left[RW_o^2 Y + (R+1)W_o S_s Y^2 + \frac{4}{3} S_s^2 Y^3 \right]_0^D \quad (\text{Eq. 6})$$

or,

$$V = RDW_o^2 + S_s D^2 (R+1)W_o + \frac{4}{3} S_s^2 D^3 \quad (\text{Eq. 7})$$



Where

V = Volume of rectangular pond

D = Depth

W_0 = Bottom width

R = Length-to-width ratio

S_s = Side Slope

Rearrange equation to solve for W_0 using quadratic equation, $0 = ax^2 + bx + c$:

$$0 = RDW_0^2 + S_s D^2 (R+1)W_0 + \frac{4}{3} S_s^2 D^3 - V \quad (\text{Eq. 8})$$

Use Quadratic Equation to solve for positive solution of W_0 , $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$:

$$W_0 = \frac{-S_s D^2 (R+1) \pm \sqrt{[S_s D^2 (R+1)]^2 - 4RD \left(\frac{4}{3} S_s^2 D^3 - V \right)}}{2RD} \quad (\text{Eq. 9})$$

Use Equation 2 for Length of pond at $Y=0$:

$$L_0 = RW_0$$

Use Equation 3 for Area of pond at $Y=0$:

$$A_0 = L_0 W_0 = RW_0^2$$

REFERENCE 6-C

STORAGE ROUTING/WATER LEVEL ANALYSIS METHODS

INTRODUCTION TO LEVEL POOL ROUTING

The level pool routing technique is one of the simplest and most commonly used routing methods. It is described in the *Handbook of Applied Hydrology* (Chow, Ven Te, 1964) and elsewhere, and it is based on the continuity equation:

Inflow - Outflow = Change in storage

$$\left[\left(\frac{I_1 + I_2}{2} \right) - \left(\frac{O_1 + O_2}{2} \right) \right] = \frac{\Delta S}{\Delta t} = S_2 - S_1 \quad (\text{Ref 6C-1})$$

where I = inflow at time 1 and time 2
 O = outflow at time 1 and time 2
 S = storage at time 1 and time 2
 Δt = time interval, $t_2 - t_1$

The time interval, Δt , must be consistent with the time interval of the inflow hydrograph or time series. The Δt variable can be eliminated by dividing it into the storage variables to obtain the following rearranged equation:

$$I_1 + I_2 + 2S_1 - O_1 = O_2 + 2S_2 \quad (\text{Ref 6C-2})$$

If the time interval, Δt , is in minutes, the units of storage S are now [cf/min] which can be approximated to cfs by multiplying by 1 min/60 sec.

The terms on the left-hand side of the equation are known from the inflow time series and from the storage and outflow values of the previous time step. The unknowns O_2 and S_2 can be solved using the stage-storage and stage-discharge relationships for the storage facility being analyzed or sized. The level pool routing procedure calls for this calculation to be made for each time step of the inflow time series in order to generate the outflow time series for the facility. Because of the repetitive nature of this procedure, it is best performed using a computer.

Developing the Stage-Storage Relationship

The following methods and equations are used for determining the stage-storage relationships of various facility types:

Facilities with Vertical Sides

For vertical-sided facilities such as vaults, the stored volume is simply the bottom area times the height.

Ponds with 3:1 Side Slopes

For ponds with 3:1 side slopes, the stored volume can be approximated by averaging the pond surface area with the bottom area. The following equation was derived based on this assumption and for a square pond but provides a reasonable trial estimation for typical ponds of other shapes.

$$S(H) = 12 H^3 + 6 \sqrt{A_b} H^2 + A_b H \quad (\text{Ref 6C-3})$$

where H = stage height (ft) or water depth above pond bottom
 A_b = area of pond bottom (sf)
 $S(H)$ = storage (cf) at stage height H

Note: Actual pond volumes and surface areas should be computed based on the methods outlined in Reference Section 6-B, or the following equation:

$$V = \frac{h}{3} (A_t + A_b + \sqrt{A_t A_b}) \quad (\text{Ref 6C-4})$$

where h = depth
 A_t = area of top
 A_b = area of the bottom

Irregularly Shaped Storage Areas

The stage-storage relationship for irregularly shaped storage areas may be developed as follows:

1. Obtain topographic contours of an existing or proposed storage facility location and determine (with a planimeter or otherwise) the area enclosed by each contour. For example, in Figure A below, each contour represents a one-foot interval. Contour 71 is the lowest portion of the facility location and represents zero storage. Contour 76 represents a potential stage of 5 feet above the bottom the facility.
2. Calculate the average end area within each set of contours. For the example in Figure A, the average end area between contours 71 and 72 would be:

$$\frac{600 + 4400}{2} = 2500 \text{ sf}$$

3. Calculate the volume between each set of contours by multiplying the average end area within each set of contours by the difference in elevation. To illustrate, the volume between contours 71 and 72 would be:

$$(2500 \text{ sf})(1 \text{ ft}) = 2500 \text{ cf}$$

Similarly,

$$\begin{aligned} \text{Area 72-73} &= 6,550 \text{ cf} \\ \text{Area 73-74} &= 10,050 \text{ cf} \\ \text{Area 74-75} &= 12,950 \text{ cf} \\ \text{Area 75-76} &= 16,750 \text{ cf} \end{aligned}$$

4. Define the total storage below each contour. This is just the sum of the volumes computed in the previous step up to the contour in question. For example, there is no storage below contour 71, 2500 cf below contour 72, and $(6550 + 2500) = 9050$ cf below contour 73.

In summary,

<u>Contours</u>	<u>Stage</u>	<u>Sum of Volumes</u>	<u>Total Volume</u>
Contours 71-72	1	0 + 2,500	= 2,500 cf
Contours 72-73	2	2,500 + 6,500	= 9,050 cf
Contours 73-74	3	9,050 + 10,050	= 19,100 cf
Contours 74-75	4	19,100 + 12,950	= 32,050 cf
Contours 75-76	5	32,050 + 16,750	= 48,800 cf

Figure B below is a plot of the stage-storage relationship for this example.

FIGURE A - STORAGE AREA CONTOURS AT ONE-FOOT INTERVALS

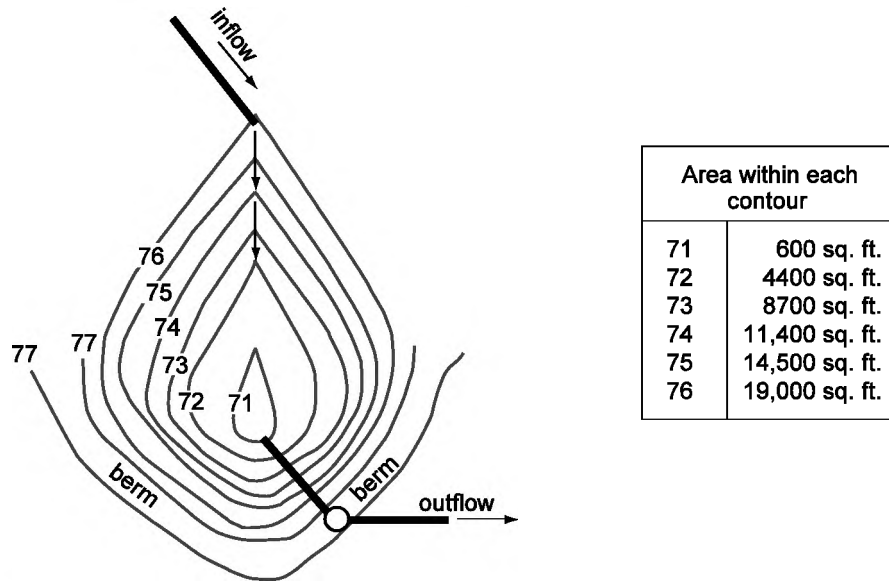
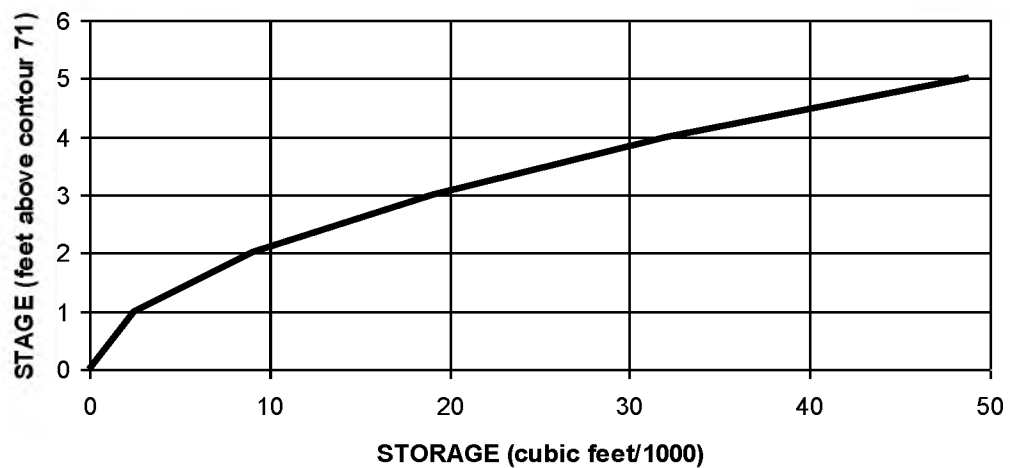


FIGURE B - STAGE-STORAGE RELATIONSHIP



Developing the Stage-Discharge Relationship

The stage-discharge relationship is determined by computing the peak discharge rate for each stage height used in the stage-storage relationship. Peak discharge rates are computed using the appropriate flow equation(s) or headwater data corresponding to the type of outlet present or proposed.

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REFERENCE 6-D

SUPPLEMENTAL MODELING GUIDELINES

Following is a list of approved models and default parameters for use specifically with the King County *Surface Water Design Manual (SWDM) (2016 edition or later)*. For general use of the model(s), including default parameters, assumptions and limitations of the model(s), see the user's documentation provided with the software.

NOTE: Modification of the default modeling parameters shall only be considered through the adjustment process per Section 1.4.

APPROVED MODELS

*Note: KCRTS is no longer maintained by King County and is **not an approved model for use with the SWDM (2016) or later editions.***

Stormwater runoff and water quality design

- MGS Flood <http://mgsengr.com/mgsfloodhome.html> (*Note: This model is not allowed for explicit modeling of bioretention*)
- WWHM2012
The latest update distributed by Ecology is downloadable at:
<https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Stormwater-manuals/Western-Washington-Hydrology-Model>
- WWHM 4
<http://www.clearcreeksolutions.info/> (*Note this model is not an approved model for use with the SWDM (2021) or later editions.*)
- Hydrologic Simulation Program (Fortran) (HSPF)
<http://water.usgs.gov/software/HSPF/>

Groundwater mounding evaluation

- MODRET ver. 6.1 or later (*Infiltration module ONLY*)
<https://www.modret.com/>
- MODFLOW
<http://water.usgs.gov/ogw/modflow/>

Backwater analysis

- KCBW
kingcounty.gov/environment/waterandland/stormwater/documents/surface-water-design-manual/hydrologic-hydraulic-model-software
- Several others as accepted during the DLS-Permitting plan review process
- Spreadsheets often used, depending on conveyance network complexity

PARAMETERS USED IN MODELING

Follow the guidance in the software user's documentation except as indicated below. Revision of default or specific parameters requires an approved adjustment per Section 1.4

General Default Parameters

Pervious and Impervious Land Categories (PERLND and IMPLND parameter values)

- In WWHM, MGS Flood and HSPF, pervious land categories are represented by PERLNDs; impervious land categories by IMPLNDs.

WWHM and MGS Flood provide over 20 unique PERLND parameters that describe various hydrologic factors that influence runoff and 4 parameters to represent IMPLND.

These default values are based on regional parameter values developed by the U.S. Geological Survey for watersheds in western Washington (Dinicola, 1990), and for the WWHM model, additional HSPF modeling work conducted by AQUA TERRA Consultants. A complete description of the PERLND parameters can be found in the HSPF User Manual,⁸ *The values are not to be revised unless approved through the adjustment process in Section 1.4.*

The precipitation stations used to develop the values represent rainfall at elevations below 1500 feet. WWHM and MGS Flood do not include snowfall and snowmelt in their analyses.

- When sizing flow control facilities, the infiltration needs to be turned off for infiltrative BMPs to avoid double-counting the infiltration/credit benefit in the sizing.

Default Parameters and SWDM-specific Guidelines by Model (periodically updated)

MGS Flood:

<http://mgsengr.com/mgsfloodhome.html>

Applicability and Limitations to MGS Flood¹

(See the full discussion of Applications and Limitations in the User's Documentation)

MGS Flood is intended for the analysis of stormwater detention facilities in the lowlands of western Washington. The program utilizes the HSPF routines for computing runoff from rainfall for pervious and impervious land areas. The program does not include routines for simulating the accumulation and melt of snow and its use should be limited to lowland areas where snowmelt is typically not a major contributor to floods or to the annual runoff volume. In general, these conditions correspond to an elevation below approximately 1500 feet.

The program is applicable for the analysis of stormwater facilities for small sites (several thousand square feet) to watersheds (10's of square miles). The program includes precipitation timeseries with a 15-minute time step for much of western Washington.

MGS Flood is not currently allowed for explicit modeling of bioretention. It will be allowed for such use when Ecology has approved it for the same.

¹ Source: *MGS Flood User's Manual, Proprietary Version*, with references to King County requirements added

Guidelines for use of MGS Flood with the SWDM:

1. Use of the Extended Precipitation Timeseries per the general model guidance is required.
2. Use the flow control exception threshold of 0.1 cfs with the 1-hr timestep. Where the 15-minute timestep is required in design (e.g., water quality facility sizing), multiply the 1-hr timestep peak value by 1.6 to approximate the 15-min timestep peak value (Reference: SMMWW 2014 BMP T9.10: Basic Biofiltration Swale, Stability Check SC-1).

Western Washington Hydrology Model (WWHM2012, WWHM4):

<https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Stormwater-manuals/Western-Washington-Hydrology-Model>

Applicability and Limitations to WWHM2012/WWHM4²

(See the full discussion of Applications and Limitations in the User's Documentation)

Ecology created WWHM for the specific purpose of sizing stormwater control facilities for new developments in western Washington. WWHM can be used for a range of conditions and developments; however, certain limitations are inherent in this software.

WWHM uses the EPA HSPF software program to do all of the rainfall-runoff and routing computations. Therefore, HSPF limitations are included in the approved model. For example, backwater or tailwater control situations are not explicitly modeled by HSPF. This is also true in the approved model.

Earlier versions of WWHM, WWHM1 and WWHM2 had limited routing capabilities. The routing capabilities of WWHM2012 have improved and the user can input multiple stormwater control facilities and runoff is routed through them. If the proposed development site involves routing through a natural lake or wetland in addition to multiple stormwater control facilities, WWHM2012 can be used to do the routing computations and additional analysis.

Routing effects become more important as the drainage area increases. For this reason, Ecology recommends that WWHM not be used for drainage areas greater than one-half square mile (320 acres). WWHM can be used for small drainage areas less than an acre in size.

Guidelines for use of WWHM2012 or WWHM4 with the SWDM:

1. King County does not allow credit for water quality treatment for flows directed through the Ecology-approved bioretention soil mix. Assure the water quality design compliance evaluation accounts for this restriction with adequate pretreatment applications.
2. Water quality facility sizing: Per the restriction in (1), flow control BMPs serving pollution-generating surfaces may require water quality treatment located immediately upstream. These water quality facilities may be sized using the tributary area characterized by BMP flow control credits.
3. Water quality reporting: When using the water quality summary feature, assure the water quality design compliance evaluation accounts for the restriction in (1) above.
4. Submittals for permit review:
Electronic files – include the following files from the model run(s):
 - WWHM2012 binary project file (.WHM file extension)
 - WWHM2012 ASCII project file (.WH2 file extension)

² Source: *Stormwater Management Manual for Western Washington (SMMWW)*, 2014 update

- WWHM2012 WDM file (.WDM file extension)
- WWHM2012 report file (Word, Rich Text or PDF file)
- Note: When viewing or printing the project report in text mode, the water quality reporting specific to elements, as selected in the LID Report accessed from the LID icon to the right of the Tools icon, will not display properly unless landscape orientation and legal size paper are selected as viewing/printing options.

MODRET ver. 6.1 or later (Infiltration module ONLY)

<https://www.modret.com/>

Training available for the software: www.suncam.com

Applicability and Limitations for MODRET ver. 6.1³

The use of MODRET for SWDM applications is limited to groundwater mounding analyses using the Infiltration module of the model.

MODRET (Computer **MODEL** to Design **RETENTION** Ponds) was originally developed in 1990, by Nicolas E. Andreyev, P.E. as a complement to a research and development project for the Southwest Florida Water Management District (SWFWMD), Brooksville, Florida. Since 1990 there have been several revisions to the original model. The user is assumed to be a professional with a background in hydrology and/or hydrogeology, and has a good command in surface runoff and groundwater flow modeling. It is assumed that the user has read the "Stormwater Retention Pond Infiltration Analysis in Unconfined Aquifers" manual (Andreyev, Wiseman, 1989, available from the author or from DNRP) and understands the applicability and limitations of the MODRET program. It is also assumed that the user is familiar with the use of personal computers, Microsoft Windows operating system and its environment.

As a whole, MODRET 6.1 is not compliant with King County requirements and SWDM methodologies. The model is tailored around southwest Florida regulatory requirements and methodologies, and allows generation of runoff hydrographs with various methods, calculation of infiltration losses from a retention pond, discharge (overflow) through various types of weirs and orifices, and generation of graphical results. However, the model's methodology and graphic output closely follow southwest Florida requirements and are not applicable for use in King County. The model's use with the SWDM is limited to the infiltration module and to the tabular output produced by the module.

Guidelines for use of MODRET 6.1 with the SWDM:

MODRET is a stormwater model based on USGS's MODFLOW and is fashioned around Florida regulatory requirements for stormwater control and pollution abatement. It is single event-based, thus it is limited in its application to King County's continuous Runoff Files Method requirements. However, it is a popular tool for evaluating groundwater mounding in infiltration facilities and is mandated by Ecology for the purpose. The Infiltration module in MODRET is the only module to be used with the SWDM.

Due to the model's event-based limitation, the Infiltration module's graphics output screens do not provide useful information for mounding analyses conducted under this manual and are not to be used unless justified by the professional preparing the analysis and report. The Input screen is the main entry point for data input. The View screen states the maximum water surface results at the bottom of the screen (scroll down to view), and the time-based results in the View screen allow a check against the seasonal rainfall pattern in the hydrograph file.

³ Source: *MODRET ver.6.1 Help files*, with references to King County requirements added.

Infiltration Module Input Screen

Unsaturated Analysis: Yes/No -- The unsaturated analysis in MODRET is an initial transitional stage where the available pore volume fills until the saturated condition is achieved. A conservative approach would not include the unsaturated analysis, ignoring the benefit of the filling of the pore volume.

Runoff Data – (selected when the inputs are completed and RUN is selected) Do not use the MANUAL option in the dropdown. Runoff data shall be prepared per Section 5.2.1, *Groundwater Mounding Analysis* and selected with the HYDROGRAPH option in the dropdown menu. The data is exported from the approved model and manipulated in a spreadsheet to the format described in the MODRET documentation, then saved as a Formatted Text space-delimited file (.PRN file extension). This file is then modified by manually changing its filename extension from .PRN to .SCS. The file is then placed in the MODRET working directory and will appear among the selections when the HYDROGRAPH option is selected.

Design Highwater Elevation, Area at Starting Water Level (area of pond bottom), ***Elevation of Pond Bottom, Elevation of Starting Water Level*** (same as pond bottom), ***Pond Length to Width Ratio*** – values are taken or calculated from the design plans for the facility.

Volume Between Starting Water Level & Estimated High Water Level – enter the calculated net volume of storage, that is, the gross storage volume of the facility multiplied by the calculated Average Effective Storage Coefficient of Pond (1.0 for an open pond, <1 for gravel trenches or tanks bedded in washed rock). The model does not do this calculation.

Average Effective Storage Coefficient of Pond – calculate from facility design plan.(1.0 for an open pond, < 1.0 for gravel trenches or tanks bedded in washed rock); use 0.35 porosity for typical 2" washed drain rock, justify any other porosity value.

Elevation of Effective Aquifer Base, Elevation of Seasonal High Groundwater Table – values determined from subsurface exploration and documented/justified in the geotechnical summary provided with the analysis. Accurate aquifer thickness data (i.e., location of the aquifer base) can be beneficial to the analysis results, but the data is often incomplete, limiting the reportable aquifer thickness to the depth of the exploration.

Average Effective Storage Coefficient of Soil for UNSATURATED Analysis, Average Effective Storage Coefficient of Soil for SATURATED Analysis -- values determined from subsurface exploration and documented/justified in the geotechnical summary provided with the analysis. The two values are typically not the same and should reflect the specific yield characteristic of the soil (the moisture content of the unsaturated soil left due to capillary forces and surface tension after gravity draining of the saturated soil).

Unsaturated Vertical Hydraulic Conductivity, Saturated Horizontal Hydraulic Conductivity -- The infiltration rate entered into the model should be the facility design infiltration rate, adjusted to exclude the geometry reduction factor, $f_{geometry}$. This infiltration rate is entered as the *Unsaturated Vertical Hydraulic Conductivity (K_{vu})* and is derived from field or lab tests (field tests include a saturation period for the receptor soils, but the results are assumed to reflect the unsaturated condition unless otherwise justified). The *Saturated Horizontal Hydraulic Conductivity* is the dominant mechanism behind mounding, being the lateral movement of the inflow volume through the soil when confined by the water table or impervious stratum below, once the pore volume in the vadose zone is filled. It is indirectly related to the Unsaturated Vertical Hydraulic Conductivity and can be approximated per the guidance in Section 5.2.1 or determined through lab tests or field pumping tests.

The effects of the geometry on groundwater mounding are captured by the model in lieu of applying the reduction factor, $f_{geometry}$, so accurate determination of the geometrical inputs is necessary for the

modeling results to be valid. Geometry influencing the analysis includes length to width ratio (L:W), design pond depth, net storage volume in the facility, separation of the facility bottom from the seasonal high groundwater table and/or impermeable layer, and location and thickness of the underlying aquifer

Factor of Safety for K_{vu} --A factor of safety of 1.0 for K_{vu} may be applied when following the guidance for determining the value for Unsaturated Vertical Hydraulic Conductivity above. The input screen for MODRET suggests a value of 2.0; software and supporting documentation indicate the suggestion accounts for plugging by sedimentation and variability of the receptor soil characteristics and field testing results. The reduction factors described in Section 5.2.1 for the Simplified Method achieve this purpose and are to be applied to determine the value for K_{vu} for MODRET input. Additional factor(s) of safety may be applied according to professional judgment.

Time Increment(s) During/After/Total for Storm Event – Use the program defaults unless otherwise justified by the professional preparing the analysis.

Additional guidance

- Allowable stress periods maximum 400 or so; time steps (aka data points) maximum count 9999 for hydrograph input files.
- The MODRET report printout will be very long (approximately 80 pages) when the water year hydrograph files described above under *Input Screen/Runoff Data* are applied. The additional pages are largely a printout of the View screen, where the progress of the model run is displayed and the maximum high water elevation information (i.e., the primary result of concern) appears at the end of the table. Consult the review staff at DLS-Permitting to determine if the intermediate portion is necessary to be included in the review submittal.
- The hydrograph input file format is described in the model appendices. It is helpful to view one of the installed .SCS files as an example for preparing the files. In a spreadsheet (e.g., Microsoft Excel), manipulate the time series file produced by the approved model to the format described in the appendix using Courier font, save as a .PRN file (i.e., Space Delimited). After exiting the spreadsheet program, replace the saved file's extension with .SCS and move the file to the working folder for MODRET. The file will show in the Hydrograph selection process of the Infiltration module.
- If the Help module in MODRET does not function, open the document(s) directly from the program folder.

Guidance for use of MODRET 6.1 with other software

- MODRET and 64 bit Win 7/8 compatibility:
MODRET is a 32 bit program that will work on 64 bit operating systems. By default, a 32 bit program will install to the "Program Files (x86)" directory on a 64 bit operating system, which causes problems for MODRET. To work around this, change the install directory to C:\MODRET. (DURING INSTALLATION)
- MODRET and Win 7/8 display compatibility:
The menus in MODRET appear black in Win 7/8. To work around this, change the display theme to the Classic, High Contrast Black, or High Contrast White theme and the menu text will display properly.
- MODRET and Acrobat for Internet Explorer:
During installation, you may receive an error related to AcroIEHelper.dll. Choose Ignore and continue with the installation. As long as you can continue viewing pdf's in your browser, this should not be an issue.

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 7
ENGINEERING PLAN SUPPORT

- 7-A KING COUNTY STANDARD MAP SYMBOLS
*See the King County Department of Transportation
CADD Standards Manual (2014) at:*
kingcounty.gov/depts/local-services/roads/cadd-standards
- 7-B STANDARD PLAN NOTES AND EXAMPLE
CONSTRUCTION SEQUENCE
- 7-C STORMFILTER FACILITY ACCESS AND
CARTRIDGE CONFIGURATION

REFERENCE 7-B

KING COUNTY STANDARD PLAN NOTES

The standard plan notes must be included on all engineering plans. Notes which in no way apply to the project may be omitted; however, the remaining notes must not be renumbered. For example, if General Note #3 were omitted, the remaining notes should remain numbered 1, 2, 4, 5, 6, etc.

GENERAL NOTES

- (1) All design and construction shall be in accordance with permit conditions, the King County Code (KCC), the King County Road Design and Construction Standards (KCRDCS), Washington State DOT (WSDOT) Standard Specifications and the conditions of preliminary approval. It shall be the sole responsibility of the applicant and the professional civil engineer to correct any error, omission, or variation from the above requirements found in these plans. All corrections shall be at no additional cost or liability to King County.
- (2) The design elements within these plans have been reviewed according to the King County Department of Local Services, Permitting Division(DLS-Permitting) Engineering Review checklist. Some elements may have been overlooked or missed by the DLS-PERMITTING plan reviewer. Any variance from adopted standards is not allowed unless specifically approved by King County prior to construction.
- (3) Approval of this road, grading, parking and drainage plan does not constitute an approval of any other construction (e.g. domestic water conveyance, sewer conveyance, gas, electrical, etc.)
- (4) Before any construction or development activity, a preconstruction meeting must be held between the DLS-PERMITTING's Development Inspector, the Applicant, and the Applicant's Construction Representative.
- (5) A copy of these approved plans must be on the job site whenever construction is in progress.
- (6) Grading activities (site alteration) are limited to the hours of 7 a.m. to 7 p.m. Monday through Saturday and 10 a.m. to 5 p.m. on Sunday, unless otherwise approved with a written decision by the Reviewing Agency.
- (7) It shall be the applicant's/contractor's responsibility to obtain all construction easements necessary before initiating off-site work. Easements require review and approval prior to construction.
- (8) Franchised utilities or other installations that are not shown on these approved plans shall not be constructed unless an approved set of plans that meet all requirements of KCRDCS Chapter 8 are submitted to the DLS-PERMITTING's Development Inspector three days prior to construction.
- (9) Datum shall be NAVD88 unless otherwise approved by DLS-PERMITTING.
- (10) Dewatering system (underdrain) construction shall be within a right-of-way or appropriate drainage easement, but not underneath the roadway section. All underdrain systems must be constructed in accordance with WSDOT Standard Specifications.
- (11) All utility trenches and roadway subgrade shall be backfilled and compacted to 95 percent maximum density per WSDOT Standard Specifications 2-03.3(14)D, Method C.
- (12) Open cutting of existing roadways for non-franchised utility or storm work is not allowed unless specifically approved by DLS-PERMITTING and noted on these approved plans. Any open cut shall be restored in accordance with KCRDCS.
- (13) The Contractor shall be responsible for providing adequate safeguards, safety devices, protective equipment, flaggers, and any other needed actions to protect the life, health, and safety of the public, and to protect property in connection with the performance of work covered by the contractor. Any work within the traveled right-of-way that may interrupt normal traffic flow shall require at least one flagger for each lane of traffic affected. Manual on Uniform Traffic Control Devices (MUTCD) shall apply. Work in right-of-way is not authorized until a traffic control plan is approved by King County.

DRAINAGE NOTES

- (1) Proof of liability insurance shall be submitted to DLS-PERMITTING prior to the construction of the drainage facilities, preferably at the preconstruction meeting.
- (2) All pipe and appurtenances shall be laid on a properly prepared foundation in accordance with WSDOT specifications. This shall include leveling and compacting the trench bottom, the top of the foundation material, and any required pipe bedding, to a uniform grade so that the entire pipe is supported by a uniformly dense unyielding base.
- (3) Steel pipe shall be aluminized, or galvanized with asphalt treatment #1 or better inside and outside.
- (4) All drainage structures, such as catch basins and manholes, not located within a traveled roadway or sidewalk, shall have solid locking lids. All drainage structures associated with a permanent retention/detention facility shall have solid locking lids.
- (5) All catch basin grates shall conform to KCRDCS, which includes the stamping "OUTFALL TO STREAM, DUMP NO POLLUTANTS" and "Property of King County", except that private drainage systems shall not have the words "Property of King County".
- (6) All driveway culverts located within King County right-of-way shall be of sufficient length to provide a minimum 3:1 slope from the edge of the driveway to the bottom of the ditch. Culverts shall have beveled end sections to match the side slope per KCRDCS.
- (7) Rock for erosion protection of roadway ditches, where required, must be of sound quarry rock, placed to a depth of 1 foot, and must meet the following specifications: 4"-8"/40%-70% passing; 2"- 4" rock/30%-40% passing; and -2" rock/10%-20% passing. Installation shall be in accordance with KCRDCS.
- (8) Drainage outlets (stub-outs) shall be provided for each individual lot, except for those lots approved for infiltration by King County. Stub-outs shall conform to the following:
 - a) Each outlet shall be suitably located at the lowest elevation on the lot, so as to service all future roof downspouts and footing drains, driveways, yard drains, and any other surface or subsurface drains necessary to render the lots suitable for their intended use. Each outlet shall have free-flowing, positive drainage to an approved stormwater conveyance system or to an approved outfall location.
 - b) Outlets on each lot shall be located with a five-foot-high, 2" x 4" stake marked "storm" or "drain". The stub-out shall extend above surface level, be visible, and be secured to the stake.
 - c) Pipe material shall conform to underdrain specifications described in KCRDCS and, if non-metallic, the pipe shall contain wire or other acceptable detection.
 - d) Drainage easements are required for drainage systems designed to convey flows through individual lots.
 - e) The applicant/contractor is responsible for coordinating the locations of all stub-out conveyance lines with respect to the utilities (e.g. power, gas, telephone, television).
 - f) All individual stub-outs shall be privately owned and maintained by the lot home owner.
- (9) All disturbed pervious areas (compacted, graded, landscaped, etc.) of the development site must demonstrate one of the following, in accordance with KCC and the Low Impact Development (LID) components of the approved site plan: The existing duff layer shall be staged and redistributed to maintain the moisture capacity of the soil, OR; Amended soil shall be added to maintain the moisture capacity.
- (10) Seasonal clearing is limited between October 1 and April 30 inclusive, unless otherwise approved with a written decision by the Reviewing Agency.
- (11) Improvements and/or buildings shall not be installed until drainage facilities are "in operation", (KCC 9.04).

EROSION AND SEDIMENTATION CONTROL NOTES

- (1) Approval of this erosion and sedimentation control (ESC) plan does not constitute an approval of permanent road or drainage design (e.g. size and location of roads, pipes, restrictors, channels, retention facilities, utilities, etc.)
- (2) The implementation of these ESC plans and the construction, maintenance, replacement, and upgrading of these ESC facilities is the responsibility of the applicant/ESC supervisor until all construction is approved.
- (3) The boundaries of the clearing limits shown on this plan shall be clearly flagged by survey tape or fencing, if required, prior to construction (King County SWDM Appendix D). During the construction period, no disturbance beyond the clearing limits shall be permitted. The clearing limits shall be maintained by the applicant/ESC supervisor for the duration of construction.
- (4) Stabilized construction entrances shall be installed at the beginning of construction and maintained for the duration of the project. Additional measures, such as constructed wheel wash systems or wash pads, may be required to ensure that all paved areas are kept clean and track out to road right of way does not occur for the duration of the project.
- (5) The ESC facilities shown on this plan must be constructed prior to or in conjunction with all clearing and grading so as to ensure that the transport of sediment to surface waters, drainage systems, flow control BMP locations (existing and proposed), and adjacent properties is minimized.
- (6) The ESC facilities shown on this plan are the minimum requirements for anticipated site conditions. During the construction period, these ESC facilities shall be upgraded as needed for unexpected storm events and modified to account for changing site conditions (e.g. additional cover measures, additional sump pumps, relocation of ditches and silt fences, perimeter protection etc.).
- (7) The ESC facilities shall be inspected daily by the applicant/ESC supervisor and maintained to ensure continued proper functioning. Written records shall be kept of weekly reviews of the ESC facilities.
- (8) Any areas of exposed soils, including roadway embankments, that will not be disturbed for two days during the wet season or seven days during the dry season shall be immediately stabilized with the approved ESC cover methods (e.g., seeding, mulching, plastic covering, etc.).
- (9) Any area needing ESC measures, not requiring immediate attention, shall be addressed within seven (7) days.
- (10) The ESC facilities on *inactive* sites shall be inspected and maintained a minimum of once a month (more frequently as required by the DLS-PERMITTING site inspector) or within 24 hours following a storm event.
- (11) At no time shall more than one (1) foot of sediment be allowed to accumulate within a catch basin. All catch basins and conveyance lines shall be cleaned prior to paving. The cleaning operation shall not flush sediment-laden water into the downstream system.
- (12) Any permanent retention/detention facility used as a temporary settling basin shall be modified with the necessary erosion control measures and shall provide adequate storage capacity. If the permanent facility is to function ultimately as an infiltration system, the temporary facility must be rough graded so that the bottom and sides are at least three feet above the final grade of the permanent facility. Flow control BMP facility areas (existing or proposed) shall not be used as temporary facilities and shall be protected from sedimentation and intrusion.
- (13) Cover measures will be applied in conformance with Appendix D of the King County Surface Water Design Manual.
- (14) Prior to the beginning of the wet season (Oct. 1), all disturbed areas shall be reviewed to identify which ones can be seeded in preparation for the winter rains. Disturbed areas shall be seeded within one week of the beginning of the wet season. A sketch map of those areas to be seeded and those areas to remain uncovered shall be submitted to the DLS-PERMITTING inspector for review.

STRUCTURAL NOTES

- (1) These plans are approved for standard road and drainage improvements only. Plans for structures such as bridges, vaults, and retaining walls require a separate review and approval by DLS-PERMITTING prior to construction (KCC 16.04, 16.70, 14.20).
- (2) Rockeries are considered to be a method of bank stabilization and erosion control. Rockeries shall not be constructed to serve as retaining walls. All rockeries in County road right-of-way shall be constructed in accordance with KCRDCS. Rockeries outside of road right-of-way shall be constructed in accordance with the International Building Code.

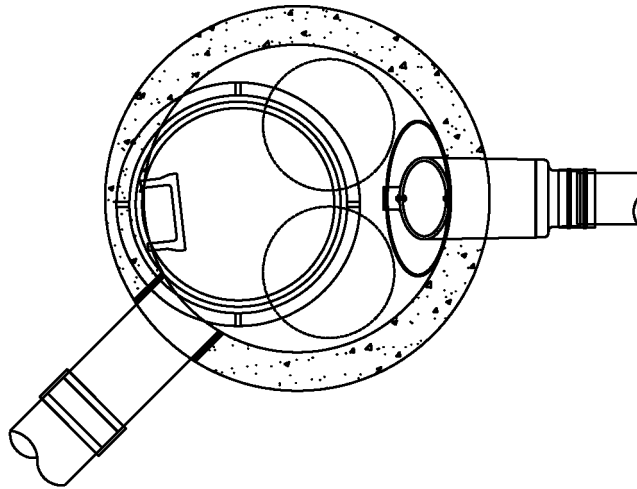
EXAMPLE CONSTRUCTION SEQUENCE**CONSTRUCTION STORMWATER POLLUTION PREVENTION RECOMMENDED CONSTRUCTION SEQUENCE**

- (1) Pre-construction meeting.
- (2) Post sign with name and phone number of CSWPP/ESC supervisor (may be consolidated with the required notice of construction sign).
- (3) Flag or fence clearing limits.
- (4) Install catch basin protection and flow control BMP area protection as required.
- (5) Grade and install construction entrance(s).
- (6) Install perimeter protection (silt fence, brush barrier, etc.).
- (7) Construct sediment ponds and traps.
- (8) Grade and stabilize construction roads.
- (9) Construct surface water controls (interceptor dikes, pipe slope drains, etc.) simultaneously with clearing and grading for project development. Construct SWPPS controls in anticipation of scheduled construction activity (e.g., concrete-related pH measures for utility, vault or roadway construction)
- (10) Maintain erosion control and SWPPS measures in accordance with King County standards and manufacturer's recommendations.
- (11) Relocate erosion control and SWPPS measures or install new measures so that as site conditions change the erosion and sediment control and pollutant protection is always in accordance with the *King County Construction Stormwater Pollution Prevention Standards*.
- (12) Cover all areas that will be unworked for more than seven days during the dry season or two days during the wet season with straw, wood fiber mulch, compost, or equivalent.
- (13) Stabilize all areas that reach final grade within seven days.
- (14) Seed or sod any areas to remain unworked for more than 30 days.
- (15) Upon completion of the project, all disturbed areas must be stabilized and BMPs removed if appropriate.

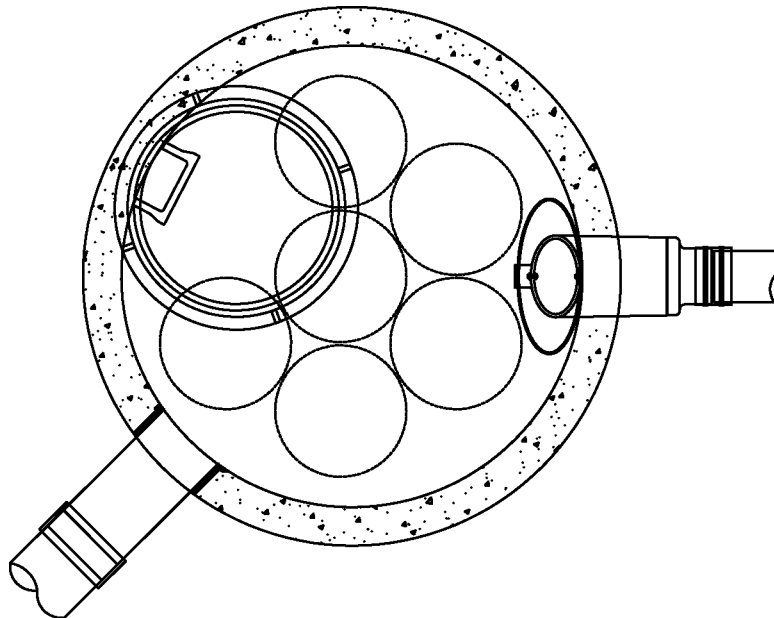
KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 7-C

**STORMFILTER FACILITY ACCESS AND
CARTRIDGE CONFIGURATION**



48" MANHOLE STORMFILTER - PLAN VIEW 1
1
1 - 30" ROUND CASTING



72" MANHOLE STORMFILTER - PLAN VIEW 2
1
1 - 30" ROUND CASTING

Note the Manhole Stormfilter is also available in a 96" configuration.
Contact the Stormfilter vendor for information.

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THE STORMWATER MANAGEMENT
StormFilter®
U.S. PATENT No. 5,322,629,
No. 5,707,527, No. 6,027,639
No. 6,649,048, No. 5,624,576,
AND OTHER U.S. AND FOREIGN
PATENTS PENDING



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**MANHOLE STORMFILTER
48" AND 72" - PLAN VIEW
ACCESS SCHEMATIC**

DRAWING

1

1/3

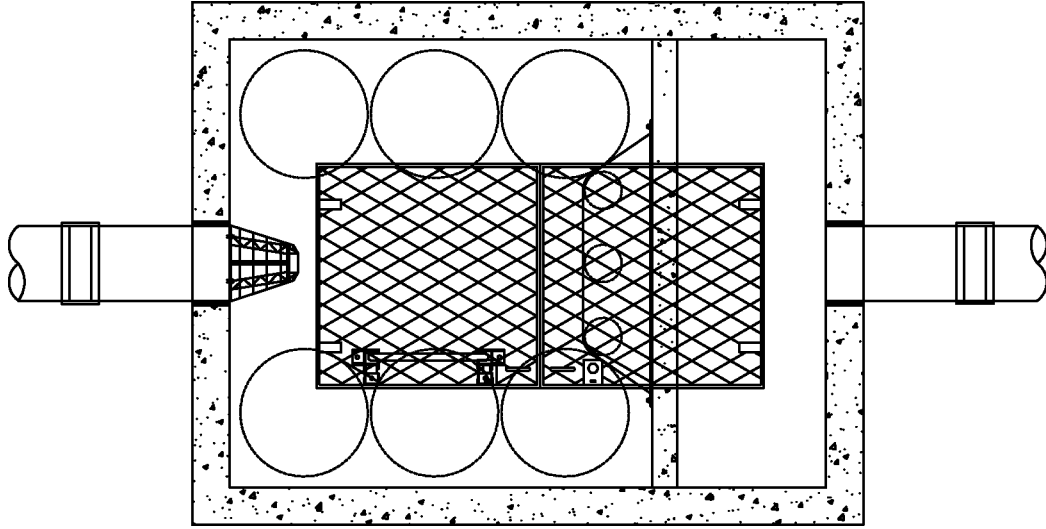
DATE: 11/29/05

SCALE: NONE

FILE NAME: KINGCOUNTY-ACCESS-SCH1

DRAWN: MJW

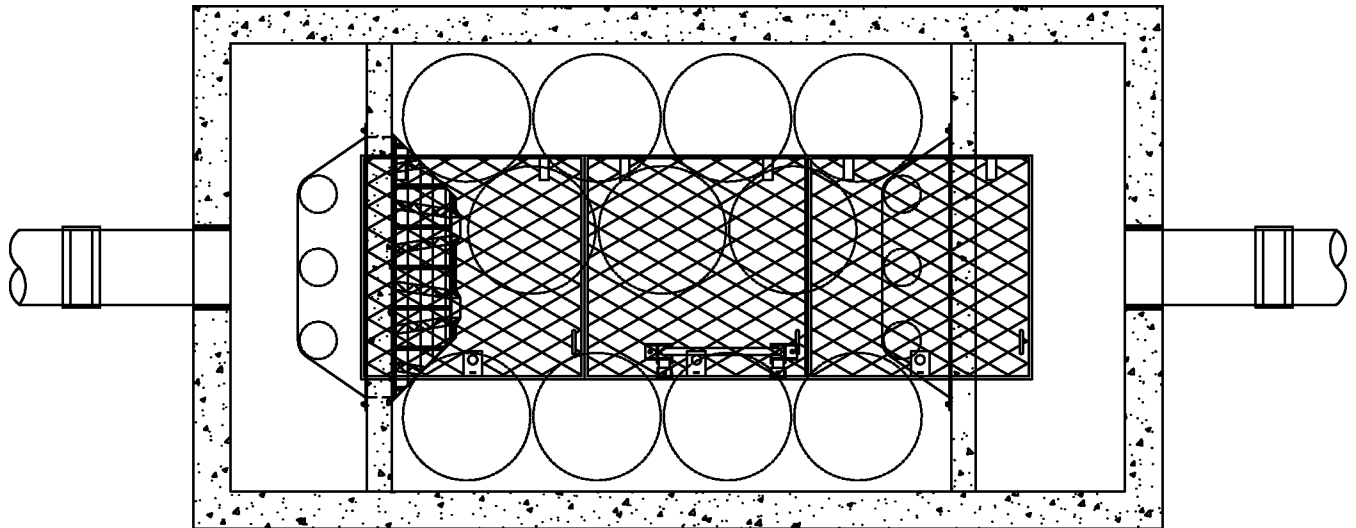
CHECKED: KT



6' x 8' PRECAST STORMFILTER - PLAN VIEW

1 - 3'X6' DOOR

1
2



6' x 12' PRECAST STORMFILTER - PLAN VIEW

1 - 3'X9' DOOR

2
2

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PRECAST STORMFILTER VAULTS
6' x 8' AND 6' x 12' - PLAN VIEW
ACCESS SCHEMATIC

DRAWING

2

2/3

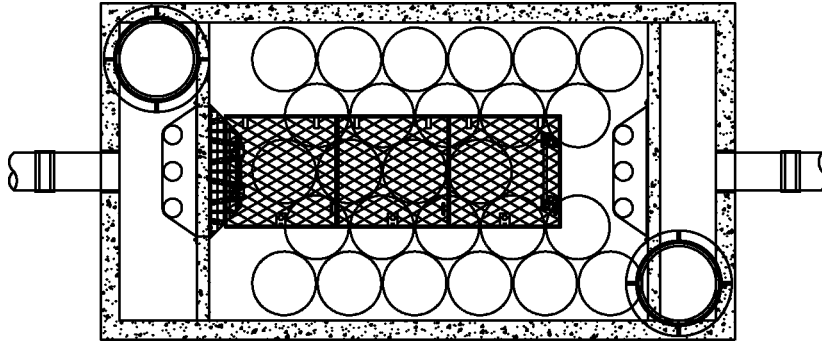
DATE: 11/29/05

SCALE: NONE

FILE NAME: KINGCOUNTY-ACCESS-SCH1

DRAWN: MJW

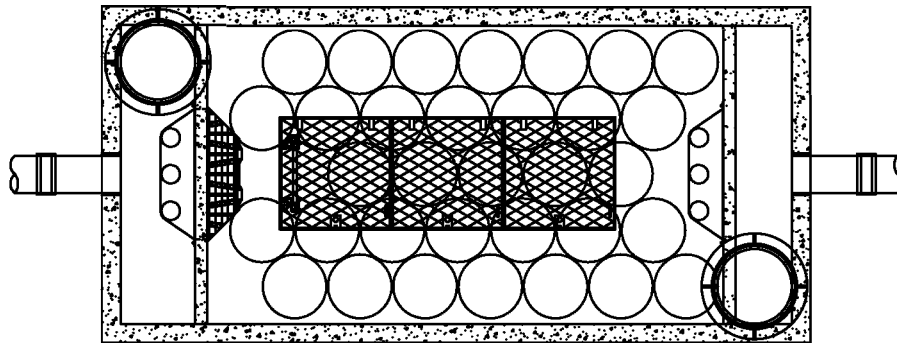
CHECKED: KT



8' x 16' PRECAST STORMFILTER - PLAN VIEW

1
3

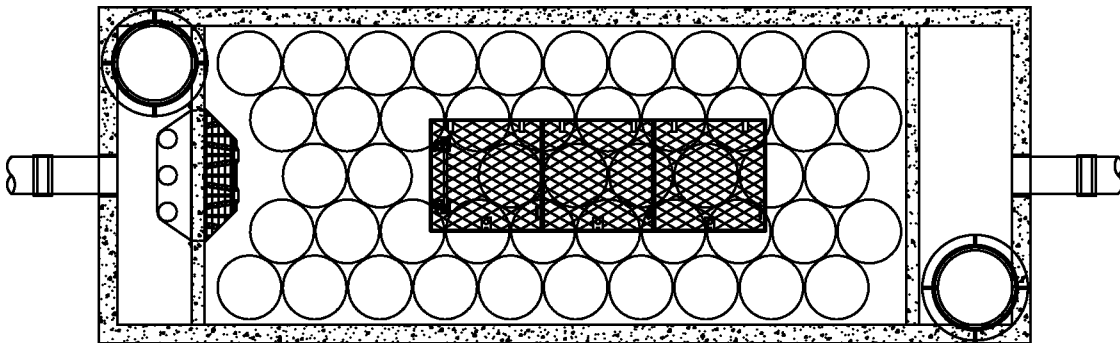
- 1 - 3'X9' DOOR
2 - 24" ROUND CASTINGS



8' x 18' PRECAST STORMFILTER - PLAN VIEW

2
3

- 1 - 3'X9' DOOR
2 - 24" ROUND CASTINGS



8' x 24' PRECAST STORMFILTER - PLAN VIEW

3
3

- 1 - 3'X9' DOOR
2 - 24" ROUND CASTINGS

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PATENTS PENDING

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PRECAST STORMFILTER VAULTS
8' x 16' AND 8' x 18' - PLAN VIEWS
ACCESS SCHEMATIC

DRAWING

3

3/3

DATE: 11/29/05

SCALE: NONE

FILE NAME: KINGCOUNTY-ACCESS-SCH2

DRAWN: MJW

CHECKED: KT

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8

PLAN REVIEW FORMS AND WORKSHEETS

- 8-A Technical Information Report (TIR) Worksheet
- 8-B Offsite Analysis Drainage System Table
- 8-C Water Quality Facility Sizing Worksheets
- 8-D Flow Control and Water Quality Facility Summary Sheet and Sketch
- 8-E CSWPP Worksheet Forms
- 8-F Adjustment Application and Process Guidelines
- 8-G Dedication and Indemnification Clause - Final Recording
- 8-H Bond Quantities Worksheet
See the current version at:
kingcounty.gov/depts/local-services/permits/infosheets-forms/permit-application-forms-title.#S
Select "Site Improvement Bond Quantity Worksheet"
- 8-I Maintenance and Defect Agreement
For the current version, contact the Financial Guarantees Management Unit at the Department of Permitting and Environmental Services, (206) 296-6659
- 8-J Declaration of Covenant
- 8-K Drainage Release Covenant
- 8-L Drainage Easement
- 8-M Flow Control BMP Covenant and BMP Maintenance Instructions (Recordable format)
- 8-N Impervious Surface Limit Covenant
- 8-O Clearing Limit Covenant
- 8-P River Protection Easement
- 8-Q Leachable Metals Covenant

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-A
TECHNICAL INFORMATION
REPORT (TIR) WORKSHEET

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 1 PROJECT OWNER AND PROJECT ENGINEER Project Owner _____ Phone _____ Address _____ _____ Project Engineer _____ Company _____ Phone _____	Part 2 PROJECT LOCATION AND DESCRIPTION Project Name _____ DLS-Permitting Permit # _____ Location Township _____ Range _____ Section _____ Site Address _____ _____
Part 3 TYPE OF PERMIT APPLICATION <input type="checkbox"/> Land use (e.g., Subdivision / Short Subd. / UPD) <input type="checkbox"/> Building (e.g., M/F / Commercial / SFR) <input type="checkbox"/> Clearing and Grading <input type="checkbox"/> Right-of-Way Use <input type="checkbox"/> Other _____	Part 4 OTHER REVIEWS AND PERMITS¹ <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <input type="checkbox"/> DFW HPA <input type="checkbox"/> COE CWA 404 <input type="checkbox"/> ECY Dam Safety <input type="checkbox"/> FEMA Floodplain <input type="checkbox"/> COE Wetlands <input type="checkbox"/> Other _____ </div> <div style="width: 45%;"> <input type="checkbox"/> Shoreline Management <input type="checkbox"/> Structural Rockery/Vault/_____ <input type="checkbox"/> ESA Section 7 </div> </div>
Part 5 PLAN AND REPORT INFORMATION	
Technical Information Report <div style="display: flex; justify-content: space-between;"> <div style="width: 40%;"> Type of Drainage Review (check one): Date (include revision dates): _____ Date of Final: _____ </div> <div style="width: 55%;"> <input type="checkbox"/> Full <input type="checkbox"/> Targeted <input type="checkbox"/> Simplified <input type="checkbox"/> Large Project <input type="checkbox"/> Directed </div> </div>	Site Improvement Plan (Engr. Plans) <div style="display: flex; justify-content: space-between;"> <div style="width: 40%;"> Plan Type (check one): Date (include revision dates): _____ Date of Final: _____ </div> <div style="width: 55%;"> <input type="checkbox"/> Full <input type="checkbox"/> Modified <input type="checkbox"/> Simplified </div> </div>
Part 6 SWDM ADJUSTMENT APPROVALS Type (circle one): Standard / Experimental / Blanket Description: (include conditions in TIR Section 2) _____ _____ _____ Approved Adjustment No. _____ Date of Approval: _____	

¹ DFW: WA State Dept. of Fish and Wildlife. HPA: hydraulic project approval. COE: (Army) Corps of Engineers. CWA: Clean Water Act. ECY: WA State Dept. of Ecology. FEMA: Federal Emergency Management Agency. ESA: Endangered Species Act.

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 7 MONITORING REQUIREMENTS

Monitoring Required: Yes / No

Start Date: _____

Completion Date: _____

Describe: _____

Re: KCSWDM Adjustment No. _____

Part 8 SITE COMMUNITY AND DRAINAGE BASIN

Community Plan : _____

Special District Overlays: _____

Drainage Basin: _____

Stormwater Requirements: _____

Part 9 ONSITE AND ADJACENT SENSITIVE AREAS

☐ River/Stream _____☐ Lake _____☐ Wetlands _____☐ Closed Depression _____☐ Floodplain _____☐ Other _____☐ Steep Slope _____☐ Erosion Hazard _____☐ Landslide Hazard _____☐ Coal Mine Hazard _____☐ Seismic Hazard _____☐ Habitat Protection _____☐ _____

Part 10 SOILS

Soil Type

Slopes

Erosion Potential

☐ High Groundwater Table (within 5 feet)☐ Sole Source Aquifer☐ Other _____☐ Seeps/Springs☐ Additional Sheets Attached

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 11 DRAINAGE DESIGN LIMITATIONS	
REFERENCE <input type="checkbox"/> Core 2 – Offsite Analysis _____ <input type="checkbox"/> Sensitive/Critical Areas _____ <input type="checkbox"/> SEPA _____ <input type="checkbox"/> LID Infeasibility _____ <input type="checkbox"/> Other _____ <input type="checkbox"/> _____	LIMITATION / SITE CONSTRAINT _____ _____ _____ _____ _____
<input type="checkbox"/> Additional Sheets Attached	
Part 12 TIR SUMMARY SHEET (provide one TIR Summary Sheet per Threshold Discharge Area)	
Threshold Discharge Area: (name or description)	
Core Requirements (all 8 apply):	
Discharge at Natural Location	Number of Natural Discharge Locations: _____
Offsite Analysis	Level: 1 / 2 / 3 dated: _____
Flow Control (include facility summary sheet)	Level: 1 / 2 / 3 or Exemption Number _____ Flow Control BMPs _____
Conveyance System	Spill containment located at: _____
Erosion and Sediment Control / Construction Stormwater Pollution Prevention	CSWPP/CESCL/ESC Site Supervisor: _____ Contact Phone: _____ After Hours Phone: _____
Maintenance and Operation	Responsibility (circle one): Private / Public If Private, Maintenance Log Required: Yes / No
Financial Guarantees and Liability	Provided: Yes / No
Water Quality (include facility summary sheet)	Type (circle one): Basic / Sens. Lake / Enhanced Basic / Bog or Exemption No. _____ Landscape Management Plan: Yes / No
For Entire Project: % of Target Impervious that had a feasible FCBMP implemented _____	Total Replaced Impervious surfaces on the site _____ Total New Pervious Surfaces on the site _____ Repl. Imp. on site mitigated w/flow control facility _____ Repl. Imp. on site mitigated w/water quality facility _____ Repl. Imp. on site mitigated with FCBMP _____

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 12 TIR SUMMARY SHEET (provide one TIR Summary Sheet per Threshold Discharge Area)	
Special Requirements (as applicable):	
Area Specific Drainage Requirements	Type: CDA / SDO / MDP / BP / LMP / Shared Fac. / None Name: _____
Floodplain/Floodway Delineation	Type (circle one): Major / Minor / Exemption / None 100-year Base Flood Elevation (or range): _____ Datum: _____
Flood Protection Facilities	Describe: _____
Source Control (commercial / industrial land use)	Describe land use: _____ Describe any structural controls: _____
Oil Control	High-use Site: Yes / No Treatment BMP: _____ Maintenance Agreement: Yes / No with whom? _____
Other Drainage Structures	
Describe: _____	

Part 13 EROSION AND SEDIMENT CONTROL REQUIREMENTS	
<p style="text-align: center;">MINIMUM ESC REQUIREMENTS DURING CONSTRUCTION</p> <p><input type="checkbox"/> Clearing Limits</p> <p><input type="checkbox"/> Cover Measures</p> <p><input type="checkbox"/> Perimeter Protection</p> <p><input type="checkbox"/> Traffic Area Stabilization</p> <p><input type="checkbox"/> Sediment Retention</p> <p><input type="checkbox"/> Surface Water Collection</p> <p><input type="checkbox"/> Dewatering Control</p> <p><input type="checkbox"/> Dust Control</p> <p><input type="checkbox"/> Flow Control</p> <p><input type="checkbox"/> Protection of Flow Control BMP Facilities (existing and proposed)</p> <p><input type="checkbox"/> Maintain BMPs / Manage Project</p>	<p style="text-align: center;">MINIMUM ESC REQUIREMENTS AFTER CONSTRUCTION</p> <p><input type="checkbox"/> Stabilize exposed surfaces</p> <p><input type="checkbox"/> Remove and restore Temporary ESC Facilities</p> <p><input type="checkbox"/> Clean and remove all silt and debris, ensure operation of Permanent Facilities, restore operation of Flow Control BMP Facilities as necessary</p> <p><input type="checkbox"/> Flag limits of SAO and open space preservation areas</p> <p><input type="checkbox"/> Other _____</p>

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 14 STORMWATER FACILITY DESCRIPTIONS (Note: Include Facility Summary and Sketch)			
Flow Control	Type/Description		Water Quality
<input type="checkbox"/> Detention	_____		<input type="checkbox"/> Vegetated Flowpath
<input type="checkbox"/> Infiltration	_____		<input type="checkbox"/> Wetpool
<input type="checkbox"/> Regional Facility	_____		<input type="checkbox"/> Filtration
<input type="checkbox"/> Shared Facility	_____		<input type="checkbox"/> Oil Control
<input type="checkbox"/> Flow Control BMPs	_____		<input type="checkbox"/> Spill Control
<input type="checkbox"/> Other	_____		<input type="checkbox"/> Flow Control BMPs
			<input type="checkbox"/> Other

Part 15 EASEMENTS/TRACTS	Part 16 STRUCTURAL ANALYSIS
<input type="checkbox"/> Drainage Easement	<input type="checkbox"/> Cast in Place Vault
<input type="checkbox"/> Covenant	<input type="checkbox"/> Retaining Wall
<input type="checkbox"/> Native Growth Protection Covenant	<input type="checkbox"/> Rockery > 4' High
<input type="checkbox"/> Tract	<input type="checkbox"/> Structural on Steep Slope
<input type="checkbox"/> Other _____	<input type="checkbox"/> Other _____

Part 17 SIGNATURE OF PROFESSIONAL ENGINEER
<p>I, or a civil engineer under my supervision, have visited the site. Actual site conditions as observed were incorporated into this worksheet and the attached Technical Information Report. To the best of my knowledge the information provided here is accurate.</p> <p style="text-align: center;">_____ <i>Signed/Date</i></p>

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-B
OFFSITE ANALYSIS
DRAINAGE SYSTEM TABLE

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE
KING COUNTY SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin:		Subbasin Name:		Subbasin Number:		Date	
---------------	--	-----------------------	--	-------------------------	--	-------------	--

[illegible]

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-C
WATER QUALITY FACILITY SIZING
WORKSHEETS

WETPOND SIZING WORKSHEET

for Rectangular Wetponds

Project Name: _____

METHODS OF ANALYSIS (See SWDM Section 6.4.1)**Step 1) Determine volume factor, f** Basic size? $f =$ 1 (unitless)Large size? $f =$ 1.5 (unitless)*Consult WQ requirements
(Section 1.2.8) to determine if
basic or large size needed***If using the 91% volume reported by the approved model, skip to ****See Section 6.2.1***Step 2) Determine weighted SCS curve number, CN**

Weighted SCS curve number, CN _____ (unitless)

*See Section 6.4.1.1***Step 3) Determine precipitation depth P for 6-mo 24-hr storm (SCS method)**

Storm depth from isopluvial or local data, or _____ (in)

72% of 2-yr 24-hr storm depth ($0.72 \times 2\text{-yr}$ _____) = _____ (in)*See Section 6.2.1***Calculate runoff depth Q_d for developed tributary area**Potential detention of area, $S = (1000/\text{weighted CN}) - 10$ _____ (in)*CN from Step 2* $P \geq 0.2S \Rightarrow Q_d = (P - 0.2S)^2 / (P + 0.8S)$ $P < 0.2S \Rightarrow Q_d = 0$ $Q_d =$ _____ (in)*P from Step 3***Step 4) Calculate Basic Volume V_b and required volume for developed tributary area**Total tributary area, A _____ (ac)*Areas used in Step 2*

Basic Volume of the wetpool,

 $V_b = 3630 \text{ (cft/ac.in.)} \times Q_d \text{ (in)} \times A \text{ (ac)}$ _____ (cf) *Q_d from Step 3**OR, if modeled,** $V_b =$ **modeled** 91% runoff volume _____ (cf)*From approved model***Required Volume of the wetpool = $f \times V_b$** _____ (cf)*Volume factor f from
Step 1***Step 5) Determine wetpool dimensions (for rectangular pond)***See Section 6.4.1.2 for flowpath length considerations***a) Determine geometry of first cell:**

Volume in first cell _____ (cf)

*25-35% of total*Depth h of first cell (minus sediment storage) _____ (ft)*See Section 6.4.1.2*

Determine first cell length at mid-depth:

Mid-depth surface area, $A_{\text{mid}} = V_{\text{first cell}} / h_{\text{first cell}}$ _____ (sf)Side slope, Z : (H):1 (V) _____ (ft)*3:1 recommended*Mid-width = (Average) Bottom width + $2(h/2 \times Z)$ _____ (ft)Mid-length = $A_{\text{mid}} / \text{Mid-width} =$ _____ (ft)*Assumes single inlet,
see Section 6.4.1.2;
Used to check L:W*

Determine area of first cell design maximum water surface, A_{top} : *(Rectangular pond)*

Side slope, Z: $\underline{\hspace{1cm}}(H):1(V)$ $\underline{\hspace{1cm}}$ (ft) *3:1 recommended*

Top width = (Average) Bottom width + $2(h \times Z)$ $\underline{\hspace{1cm}}$ (ft)

Top length = Bottom length + $2(h \times Z)$

$A_{top} = (\text{Top width}) \times (\text{Top Length}) = \underline{\hspace{1cm}}$ (sf)

b) Determine geometry of second cell

Volume in second cell $\underline{\hspace{1cm}}$ (cf) *Must be 65 - 75%*

Depth h of second cell $\underline{\hspace{1cm}}$ (ft) *See Section 6.4.1.2*

Determine cell length at mid-depth:

Mid-depth surface area, $A_{mid} = V_{\text{second cell}} / h_{\text{second cell}}$ $\underline{\hspace{1cm}}$ (sf)

Side slope, Z: $\underline{\hspace{1cm}}(H):1(V)$ $\underline{\hspace{1cm}}$ (ft) *3:1 recommended*

Mid-width = (Average) Bottom width + $2(h/2 \times Z)$ $\underline{\hspace{1cm}}$ (ft)

Mid-length = $A_{mid} / \text{Mid-width} = \underline{\hspace{1cm}}$ (ft) *Used to check L:W*

Determine area of second cell design maximum water surface, A_{top} *(Rectangular pond)*

Side slope, Z: $\underline{\hspace{1cm}}(H):1(V)$ $\underline{\hspace{1cm}}$ (ft) *3:1 recommended*

Top width = (Average) Bottom width + $2(h \times Z)$ $\underline{\hspace{1cm}}$ (ft)

Top length = Bottom length + $2(h \times Z)$

$A_{top} = (\text{Top width}) \times (\text{Top Length}) = \underline{\hspace{1cm}}$ (sf)

c) Geometry check: overall pond L:W at mid-depth at least 3:1

Weighted Average pond width (mid-depth) $\underline{\hspace{1cm}}$ (ft)

$[\sum(\text{Cell } A_{mid})(\text{Cell Avg width all cells})] / [\sum(A_{mid} \text{ all cells})]$

Cell 1 length (mid-depth) $\underline{\hspace{1cm}}$ (ft) *See Section 6.4.1.2*

Cell 2 length (mid-depth) $\underline{\hspace{1cm}}$ (ft) *for flowpath length*

Pond length (mid-depth) = cell 1 + 2 $\underline{\hspace{1cm}}$ (ft) *considerations*

$L_{mid} : W_{mid} = \underline{\hspace{1cm}}$

Step 6) Design rest of pond (see Criteria p. 6-73)

Internal berm	Other Design Details (Sections 6.2.2, 6.2.3, and 6.2.4)
Inlet & Outlet	Sequence of Facilities
Primary overflow	Setbacks
Access	Sideslopes, fencing, embankment
	Liners

Total wetpond surface area estimate

Sum areas for design maximum water surface (all cells), internal berm, access ramp

= $\underline{\hspace{1cm}}$ (sf)

+ $\underline{\hspace{1cm}}$ (sf)

+ $\underline{\hspace{1cm}}$ (sf)

+ $\underline{\hspace{1cm}}$ (sf)

= $\underline{\hspace{1cm}}$ Total sf

Pond tract area will also
include setbacks, access
roads, 100-yr conveyance, etc.

WETVAULT SIZING WORKSHEET

Project Name: _____

METHODS OF ANALYSIS (See SWDM Section 6.4.2)

Step 1) Determine volume factor, f

Basic size? $f = \underline{\hspace{1cm}} 1 \hspace{1cm}$ (unitless)

Large size? $f = \underline{\hspace{1cm}} 1.5 \hspace{1cm}$ (unitless)

*Consult WQ requirements
(Section 1.2.8) to determine if
basic or large size needed*

If using the 91% volume reported by the approved model, skip to *

See Section 6.2.1

Step 2) Determine weighted SCS curve number, CN

Weighted SCS curve number, CN (unitless)

See Section 6.4.1.1

Step 3) Determine precipitation depth P for 6-mo 24-hr storm (SCS method)

Storm depth from isopluvial or local data, or (in)

72% of 2-yr 24-hr storm depth ($0.72 \times 2\text{-yr}$) = (in)

See Section 6.2.1

Calculate runoff depth Q_d for developed tributary area

Potential detention of area, $S = (1000/\text{weighted CN}) - 10$ (in)

CN from Step 2

$P \geq 0.2S \Rightarrow Q_d = (P - 0.2S)^2 / (P + 0.8S)$

$P < 0.2S \Rightarrow Q_d = 0$

$Q_d = \underline{\hspace{1cm}}$ (in)

P from Step 3

Step 4) Calculate Basic Volume V_b and required volume for developed tributary area

Total tributary area, A (ac)

Areas used in Step 2

Basic Volume of the wetpool,

$V_b = 3630 \text{ (cft/ac.in.)} \times Q_d \text{ (in)} \times A \text{ (ac)}$ (cf)

Q_d from Step 3

OR, if modeled,

* $V_b = \text{modeled 91\% runoff volume}$ (cf)

From approved model

Required Volume of the wetpool = $f \times V_b$

 (cf)

*Volume factor f
from Step 1*

Step 5) Determine wetpool dimensions

a) *Determine geometry of first cell*

Volume in first cell (cf)

Must be 25 - 35%

Depth h of first cell (minus sediment storage) (ft)

See Section 6.4.1.2

Determine area at water surface = (Volume/ h)

Atop = (sf)

Find top dimensions by adjusting for shape geometrics

Dimensions of first cell: width = (ft)

length = (ft)

b) Determine geometry of second cell

Volume in second cell _____ (cf) *Must be 65 - 75%*
 Depth h of second cell _____ (ft) *See Section 6.4.1.2*
 Determine area at water surface = (Volume/ h)
 A_{top} = _____ (sf)
 Dimensions of second cell: width = _____ (ft) *Same as Cell 1*
 length = _____ (ft)

c) Geometry check: overall pond L:W at mid depth at least 3:1

Cell 1 length (mid-depth) _____ (ft)
 Cell 2 length (mid-depth) _____ (ft)
 Vault length = cell 1 + 2 _____ (ft)
 Vault width _____ (ft)
 At mid-depth, $L_{mid} : W_{mid} =$ _____

Step 6) Design rest of vault (Section 6.4.2.1)

Internal baffle

Inlet & Outlet

Access (note 5'X10" access, grating and corner vent holes)

Effective impervious area (EIA) _____

See Section 3.2.2.1

Other Design Details (Sections 6.2.2, 6.2.3, and 6.2.4)

Sequence of Facilities

Setbacks

Sideslopes, fencing, embankment

SIZE SUMMARY: Surface area, change in elevation

Vault width _____ (ft)
 Vault length _____ (ft)
 Surface area _____ (sf)
 Elevation change needed: _____ (ft)

STORMWATER WETLAND SIZING WORKSHEET

Project Name: _____

METHODS OF ANALYSIS (See SWDM Section 6.4.3)

Step 1) Determine volume factor f .

Use Basic size $f =$ _____ 1 *See WQ requirements (Section 1.2.8) and Section 6.4.3.1*

*If using the 91% volume reported by the approved model, skip to ** *See Section 6.2.1*

Step 2) Determine weighted SCS curve number, CN

Weighted SCS curve number, CN _____ (unitless) *See Section 6.4.1.1*

Step 3) Determine precipitation depth P for 6-mo 24-hr storm (SCS method)

Storm depth from isoplethial or local data, or _____ (in) *See Section 6.2.1*
 72% of 2-yr 24-hr storm depth $(0.72 \times 2\text{-yr} \text{ _____ }) =$ _____ (in)

Calculate runoff depth Q_d for developed tributary area

Potential detention of area, $S = (1000/\text{weighted CN}) - 10$ _____ (in) *CN from Step 2*

$$P \geq 0.2S \Rightarrow Q_d = (P - 0.2S)^2 / (P + 0.8S)$$

$$P < 0.2S \Rightarrow Q_d = 0 \quad Q_d = \text{_____ (in)} \quad P \text{ from Step 3}$$

Step 4) Calculate Basic Volume V_b and required volume for developed tributary area

Total tributary area, A _____ (ac) *Areas used in Step 2*

Basic Volume of the wetpool,

$$V_b = 3630 \text{ (cft/ac.in.)} \times Q_d \text{ (in)} \times A \text{ (ac)} \quad \text{_____ (cf)} \quad Q_d \text{ from Step 3}$$

OR, if modeled,

* $V_b =$ **modeled** 91% runoff volume _____ (cf) *From approved model*

Required Volume of the wetpool = $f \times V_b$ _____ (cf) *Volume factor $f=1$ from Step 1*

Step 5) Calculate required wetland surface area

$$A_{\text{top, total}} = V_b / 3 \quad (\text{total surface area of both cells}) \quad \text{_____ (sf)}$$

$$\text{template } V_b = \text{_____ (cf)} \quad \text{From Step 4}$$

$$A_{\text{top, total}} = \text{_____ (sf)} \quad \text{"Sizing" depth is 3 ft}$$

Step 6) Determine wetland cell dimensions

(Same as Steps 6, 7 & 8, KCSWDM 6.4.3.1)

a) Determine geometry of first cell

Set volume of first cell equal to V_r _____ (cf) *From Step 3*

Depth h 1st cell (minus sediment storage) _____ (ft) *Note actual cell depth may be from 4 to 8 ft*

Determine first cell surface area at mid-depth:

$$\text{Mid-depth surface area, } A_{\text{mid}} = V_{\text{first cell}} / h_{\text{first cell}} \quad \text{_____ (sf)}$$

Find mid-depth dimensions by adjusting for shape geometrics

Side slope, Z: (H):1 (V) (ft) *3:1 recommended*Mid-width = (Avg) Bottom width + 2(h/2 x Z) (ft)Mid-length = $A_{mid} / \text{Mid-width} =$ (ft) *Assumes single inlet, see Section 6.4.1.2; Used to check L:W*

Find top dimensions by adjusting for shape geometrics

Top width $W_{top} = (\text{Avg}) \text{ mid-width} + 2(h/2 \times Z)$ (ft) *(for Rectangular facility)*Top length $L_{top} = \text{Mid-length} + 2(h/2 \times Z)$ (ft)

Determine first cell surface area at design maximum water surface:

 $A_{top1} = A_{mid} + (h/2 \times Z \times \text{perimeter}_{mid}) =$ (sf) *General equation**or,* $A_{top1} = A_{mid} + (h \times Z \times (L_{mid} + W_{mid})) =$ (sf) *(for Rectangular facility)**or,* $A_{top1} = (L_{top} \times W_{top}) =$ (sf)**b) Determine geometry of second cell**Wetland surface area $A_{top, total}$ (sf) *From Step 5*Surface area of second cell = $A_{top, total} - A_{top1}$ (sf)Depth h of second cell varies, 1.5' avg *See Table 6.4.3.A and Criteria #8, p.6-90***Step 7) Choose plants for wetland cell**

See recommendations in Table 6.4.1.A, p. 6-75

Step 8) Design rest of pond (See p. 6.4.3.2 for Criteria)

Internal berm	Other Design Details (Sections 6.2.2, 6.2.3, and 6.2.4)
Inlet & Outlet	Sequence of Facilities
Primary overflow	Setbacks
Access	Sideslopes, fencing, embankment
	Liners

Total stormwater wetland surface area estimate*Sum areas for design maximum water surface (all cells), internal berm, access ramp*= (sf)+ (sf)+ (sf)+ (sf)= Total sf*Pond tract area will also include setbacks, access roads, 100-yr conveyance, etc.*

BIOSWALE WORKSHEET

Project Name: _____

METHODS OF ANALYSIS (See SWDM Section 6.3.1.1)

Step 1) Calculate design flows

- Bioswales generally precede other water quality facilities (See menus in Section 6.1)
- Design flows depend on sequence with detention facility. (Section 6.2.1)

Preceding detention	Q_{wq} = modeled flow achieving 91% developed flow volume treated
Following detention	Q_{wq} = 2-yr release rate from detention facility

If no high flow bypass provided: Q_{100-yr} _____ (cfs) See Section 6.3.1.1
 Q_{25-yr} _____ (cfs) See Section 3.2.2 Runoff Files Method
 Q_{2-yr} _____ (cfs) "
 Water quality design flow Q_{wq} _____ (cfs) Section 6.2.1 WQ Design Flows and Volumes

Land Cover Areas and Soil Types

See Tables 3.2.2 B and 3.2.2.C

Forest	<input type="checkbox"/> till	<input type="checkbox"/> outwash	_____ (acres)	Areas draining to swale (Section 3.2.2)
Pasture	<input type="checkbox"/> till	<input type="checkbox"/> outwash	_____ (acres)	"
Grass	<input type="checkbox"/> till	<input type="checkbox"/> outwash	_____ (acres)	"
Wetland			_____ (acres)	"
Impervious			_____ (acres)	"

Time Step: 15-min _____ 15-min Required "15 min" (Section 6.2.1)

Step 2) Calculate swale bottom width

$b = \frac{Q_{wq} n_{wq}}{1.49 y^{1.67} s^{0.5}}$ bottom width of swale _____ (ft) Simplified Manning's formula

Q_{wq} = water quality design flow _____ (cfs) Listed in Step 1
 n_{wq} = Manning's roughness coefficient 0.20 Required 0.20, shallow flow conditions
 y = design flow depth _____ (ft) Mowed 2 in. (0.17ft), Rural 4 in. (0.33ft)
 s = longitudinal slope, along flow _____ (feet/ft)

- If the bottom width is calculated to be between 2 and 10 feet, proceed to Step 3.
- If bottom width is less than 2 feet, increase width to 2 feet and recalculate the design flow depth (y).
- If bottom width is more than 10 feet, increase longitudinal slope (s), increase design flow depth (y), install flow divider and flow spreader, or relocate swale after detention facility

Step 3) Determine design flow velocity

$V_{wq} = Q_{wq} / A_{wq}$ design flow velocity _____ (fps) Flow Continuity Equation, Q_{wq} from Step 1
 $A_{wq} = by + Zy^2$ _____ (sf) Cross-sectional area at design depth
 Z = side slope length per unit height _____ (feet/ft) Select now

- If the velocity exceeds 1.0 fps, go back to Step 2 and modify longitudinal slope, bottom width, or depth.
- If the velocity is less than 1.0 fps, proceed to Step 4.

Step 4) Calculate swale length

$$L = 540V_{wq} = \text{swale length} \quad \underline{\hspace{2cm}} \quad (\text{ft})$$

$$540 = \text{hydraulic residence time} \quad \underline{\hspace{2cm}} \quad (\text{s})$$

$$V_{wq} = \text{design flow velocity} \quad \underline{\hspace{2cm}} \quad (\text{fps}) \quad \text{Calculated in Step 3}$$

- If the length is less than 100 feet, increase the length to 100 feet, leaving the bottom width unchanged.
- If the swale length can be accommodated on the site, proceed to Step 6.
- If the length is too long for the site, proceed to Step 5.

Step 5) Adjust swale layout to fit on site.

Increase initial bottom width and reduce initial swale length to provide an equivalent top area.

$$\text{Required area } A_{\text{top}} = (b_i + b_{\text{slope}})L_i = (b_f + b_{\text{slope}})L_f \quad \underline{\hspace{2cm}} \quad (\text{sf}) \quad \text{Calculate top area at WQ design depth}$$

$$b_f = \text{increased bottom width} \quad \underline{\hspace{2cm}} \quad (\text{ft}) \quad \text{Select now; see Sections 6.3.1.2 and 6.3.2.2}$$

$$b_{\text{slope}} = 2Zy \text{ (ft) top width above sides} \quad \underline{\hspace{2cm}} \quad (\text{ft}) \quad \text{for max. allowable width}$$

$$L_f = \text{reduced length, } A_{\text{top}} / (b_f + b_{\text{slope}}) \quad \underline{\hspace{2cm}} \quad (\text{ft}) \quad \text{Select now; Required minimum 100 ft}$$

- Go to Step 3 and recalculate design flow velocity (v) using b_f .
- **Recalculate to assure the 9 minute retention**

Step 6) Provide conveyance capacity for flows higher than Q_{wq}

Meet conveyance requirements of Section 1.2.4 and check conveyance and velocity of high flows.

$$\text{A) } Q_c = (1.49/n_c) A_c R_c^{0.67} s^{0.5} \quad \underline{\hspace{2cm}} \quad (\text{cfs}) \quad \text{Manning's Eq.; 100-yr or 25-yr flow in Step 1}$$

$$n_c = \text{Manning's roughness coefficient} \quad \underline{\hspace{2cm}} \quad \text{Manning's "n" from Table 4.4.1 B}$$

$$A_c = b y_c + Z y_c^2 \quad \underline{\hspace{2cm}} \quad (\text{sf}) \quad \text{Cross sectional area (trapezoidal section)}$$

$$R_c = A_c / (b + 2y_c(Z^2 + 1)^{0.5}) \quad \underline{\hspace{2cm}} \quad (\text{ft}) \quad \text{Hydraulic Radius (trapezoidal section)}$$

$$s = \text{longitudinal slope, along flow} \quad \underline{\hspace{2cm}} \quad (\text{ft/ft}) \quad \text{Selected in Step 2}$$

$$y_c = \text{depth of 25-yr or 100-yr flows} \quad \underline{\hspace{2cm}} \quad (\text{ft}) \quad \text{Calculate now}$$

- Check velocity of 100-yr peak flow...

$$\text{B) } V_{100} = Q_{100} / A_{100} \quad \underline{\hspace{2cm}} \quad (\text{fps})$$

- If V_{100} exceeds 3.0 fps, return to Step 2 and increase the bottom width or flatten slope.

Size Summary (Plan Area)

- Land area is needed for the channel (top width including freeboard and any low-flow drain width), access, setbacks, and, if necessary, area to convey high flows.
- Longitudinal cross section includes conveyance depth y_c , swale plan length L_{plan} (channel elevation drop / slope), and, if necessary, underdrain and high flows.

$$L_{\text{plan}} (\text{channel elevation drop (ft) / slope}) = \underline{\hspace{2cm}} \quad (\text{ft}) \quad \text{From Steps 3, 4 and 6}$$

$$\text{WS plan area } A_{\text{plan}} = L_{\text{plan}} \times (b + 2Zy_c) = \underline{\hspace{2cm}} \quad (\text{sf}) \quad y_c \text{ from Step 6}$$

OTHER CRITERIA (Section 6.3.1.2)

Swale Geometry
Water Depth

Setbacks (Section 6.2.3)
Soil and plantings

Underdrains
Swale Divider

FILTER STRIP WORKSHEET

Project Name: _____

METHODS OF ANALYSIS (See SWDM Section 6.3.4)

Step 1) Calculate design flows

Filter strips usually precede other water quality facilities (See menus in Section 6.1)

Two-year flow	Q_{2-yr}	<u> </u> (cfs)	Section 6.2.1 WQ Design Flows
Water quality design flow	Q_{wq}	<u> </u> (cfs)	"

Step 2) Calculate design flow depth

Q_{wq} = water quality design flow	<u> </u> (cfs)	Calculated in Step 1
n_{wq} = Manning's roughness coefficient	<u> </u>	Use 0.35 or 0.45, see p. 6-62
W = width of strip along imperv.	<u> </u> (ft)	Determine now
s = longitudinal slope along path	<u> </u> (feet/ft)	Determine now

$d_f = \left| \frac{Q_{wq} n_{wq}}{1.49 W s^{0.5}} \right|^{0.6}$ design flow depth, $d_f =$ (ft) Manning's formula, re-arranged

- If the design flow depth is greater than 1 inch (0.083 ft), the flow must be reduced, the strip width must be increased, or a different WQ facility must be used.

CHECK: (ft) < 0.083 ft, OK

Step 3) Calculate the design flow velocity through the strip

Q_{wq} =	<u> </u> (cfs)	From Step 1
W =	<u> </u> (ft)	From Step 2
d_f =	<u> </u> (ft)	From Step 2
$V_{wq} = Q_{wq} / W d_f$	<u> </u> (fps)	Flow Continuity Eq. w/ $W d_f$ for A

- If V_{wq} exceeds 0.5 fps, a filter strip may not be used. Redesign site to use a gentler longitudinal slope, or use another WQ facility.

CHECK: (fps) < 0.5 fps, OK

Step 4) Calculate length of filter strip

hydraulic residence time =	<u>540</u> (s)	Required 9 minutes
design flow velocity, V_{wq} =	<u> </u> (fps)	Calculated in Step 3
$L = 540 V_{wq}$	<u> </u> (ft)	

Size Summary

Land area is needed for the strip, access, & area outside the treatment area to convey high flows

Other Criteria

Flow spreading & energy dissipation	Planting requirements
Access	Liners (Section 6.2.4)
Soil amendment	Recommended design features (Section 6.3.4.2)

BAFFLE OIL/WATER SEPARATOR WORKSHEET

Project Name: _____

METHODS OF ANALYSIS (See SWDM Section 6.6.2.1)

Step 1) Calculate design flows (must be designed as an off-line facility)

Tributary area _____ (sf) *See Section 6.2.1 WQ Design*
 Water quality off-line design flow, Q_{wq} _____ (cfs) *Flows and Volumes*

Step 2) Calculate the minimum vertical cross-sectional area

$A_c = Q_{wq} / V_H$ (Required: $V_H = 15V_T$)
 Q_{wq} = water quality design flow _____ (cfs) *From Step 1*
 V_T = oil droplet rise rate 0.033 (fpm) *Use 0.033 fpm or justify alt. value*
 V_H = design horizontal velocity 0.008 (fps) *$V_H = 15V_T$; for $V_T = .033$ fpm,
 $V_H = 0.008$ fps*
 A_c = minimum cross-sectional area _____ (sf)

Step 3) Calculate the width and depth of the vault

$D = A_c / W$
 W = width of vault _____ (ft) *Required $6' \leq W \leq 20'$*
 A_c = minimum cross-sectional area _____ (sf) *From Step 2*
 D = maximum depth _____ (ft) *Required $3' \leq D \leq 8'$ per ECY*

The computed depth D must meet a depth-to-width ratio r of between 0.3 and 0.5

Note: $D = (rA_c)^{0.5}$
 r = depth-to-width ratio
 $W = D/r$ *If $0.3 \leq D/W \leq 0.5$, OK;
 if not, revise D , W*
 CHECK: Design $D/W =$ _____

Step 4) Calculate the length of the vault

$L = FD (V_H/V_T)$
 L = Length of vault
 V_H = horizontal velocity (fpm)
 V_T = oil droplet rise rate (fpm) *$V_H/V_T = 15$, required*
 D = depth _____ (ft) *From Step 3*
 F = turbulence and short-circuiting factor 1.64 *$F = 1.64$, required (Fig. 6.6.2.A,
 using $V_H/V_T = 15$)*

Therefore: $L = 1.64 \times 15 \times D$ $L =$ _____ (ft)

Step 5) Check the separator's length-to-width ratio and forebay length.

Vault $L/W =$ _____ *Vault L/W must be 5 or greater*
 Length of forebay _____ (ft)
 $L_{forebay} / L_{vault} =$ _____ *$L_{forebay}$ must be approx. $L_{vault}/3$*

Step 6) Check that the minimum horizontal surface area A_H criterion is satisfied

$$A_H = FQ_{wq} / V_t ; \quad \text{Required: } A_H \leq (L \times W)_{\text{design}}$$

$$Q_{wq} = \underline{\hspace{2cm}} \quad (\text{cfs})$$

From Step 1

$$A_H = (1.64 \times Q_{wq} / 0.00055) \quad \underline{\hspace{2cm}} \quad (\text{sf})$$

From Steps 4 and 2, V_t in fps

$$\text{Design } L \times W = \underline{\hspace{2cm}} \quad (\text{sf})$$

Required: $A_H \leq (L \times W)_{\text{design}}$ **Step 7) Compute and check the horizontal surface area of the vault forebay.***This area must be greater than 20 square feet per 10,000 square feet of tributary impervious area*

$$L = \text{length of vault} \quad \underline{\hspace{2cm}} \quad (\text{ft})$$

Step 4

$$L_F = \text{length of forebay} \quad \underline{\hspace{2cm}} \quad (\text{ft})$$

Step 5

$$W = \text{width of vault} \quad \underline{\hspace{2cm}} \quad (\text{ft})$$

Step 3

$$A_{F, \text{design}} = \text{forebay area} = L_F \times W \quad \underline{\hspace{2cm}} \quad (\text{sf})$$

$$A_{TI} = \text{tributary impervious area} \quad \underline{\hspace{2cm}} \quad (\text{sf})$$

Required: $A_F : A_{TI} > 1:500$, or

$$\text{Required min. area for } A_F = (20 \times A_{TI} / 10,000) \quad \underline{\hspace{2cm}} \quad (\text{sf})$$

If $<$ Design forebay area, OK

$$A_{F, \text{design}} : A_{TI} = \underline{\hspace{2cm}} : 500$$

*If $> 1:500$, OK***Step 8) Design the flow splitter and high-flow bypass.***See Section 6.2.5 for information on flow splitter design.***OTHER CRITERIA (Section 6.6.2.2)**

General siting before other stormwater facilities

Baffle requirements

Inlet & outlet

Material requirements

Maintenance access (also see Section 5.3.3.1)

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-D

**FLOW CONTROL AND WATER
QUALITY FACILITY SUMMARY SHEET
AND SKETCH**

STORMWATER FACILITY SUMMARY SHEET

(provide one Stormwater Facility Summary Sheet per *Natural Discharge Location*)

OVERVIEW:

Project Name _____

Project Location _____

Downstream Drainage Basins:

Major Basin Name _____

Immediate Basin Name _____

GENERAL FACILITY INFORMATION:

Detention		Infiltration		Water Quality		Flow Control Performance Std
Type	# of	Type	# of	Type	# of	
Ponds	_____	Ponds	_____	Ponds	_____	<input type="checkbox"/> Basic
Vaults	_____	Tanks	_____	Vaults	_____	<input type="checkbox"/> Conservation
Tanks	_____	renches	_____	Tanks	_____	<input type="checkbox"/> Flood Problem

If no flow control facility, check one:

- ☐ Project qualifies for KCSWDM Exemption (KCSWDM 1.2.3):
- ☐ Basic Exemption
 - ☐ Impervious Surface Exemption for Transportation
Redevelopment projects
 - ☐ Cost Exemption for Parcel Redevelopment projects
 - ☐ Direct Discharge Exemption
 - ☐ Other _____
- ☐ Project qualifies for 0.1 cfs Exception per KCSWDM 1.2.3
- ☐ No flow control required per approved
KCSWDM Adjustment No. _____
- ☐ Flow control provided in regional/shared facility per approved
approved KCSWDM Adjustment No. _____
Shared Facility Name/Location: _____
- ☐ No flow control required (other, provide justification): _____

DPER Permit No. _____

Date _____

NPDES Permit No. _____

Parcel No. _____

Retired Parcel No. _____

Project includes Landscape Management Plan? yes ☐
(include copy with TIR as Appendix) no ☐

Declarations of Covenant

Leachable Metals

Impervious Surface Limit

Flow Control BMPs

Clearing Limit

Drainage Facility

Landscape Management Plan

Recording No.

TREATMENT SUMMARY FOR TOTAL IMPERVIOUS SURFACES

(Applies to Commercial parcels only)	Area	% of Total
Total Acreage (ac)		-----
Total Impervious Acreage (ac)		
Total impervious surface served by flow control facility(ies) (sq ft)		
Impervious surface served by flow control facility(ies) designed 1990 or later (sq ft)		
Impervious surface served by pervious surface absorption (sq ft)		
Impervious surface served by approved water quality facility(ies) (sq ft)		

PROVIDE FACILITY DETAILS AND FACILITY SKETCH FOR EACH FACILITY ON REVERSE. USE ADDITIONAL SHEETS AS NEEDED FOR ADDITIONAL FACILITIES

STORMWATER FACILITY SUMMARY SHEET(provide one Stormwater Facility Summary Sheet per *Natural Discharge Location*)

DPER Permit No. _____

Project Name
Project Location

Downstream Drainage Basins:

Major Basin Name _____

Immediate Basin Name _____

FLOW CONTROL FACILITY:		Basin:	
Facility Name/Number _____		<input type="checkbox"/> New Facility	
Facility Location _____		<input type="checkbox"/> Existing Facility	
UIC? <input type="checkbox"/> yes <input type="checkbox"/> no UIC Site ID: _____		Project Impervious Acres Served _____ % of Total Project Impervious Acres Served _____ No. of Lots Served _____	
Live Storage _____ <input type="checkbox"/> cu.ft.	Live Storage _____		Volume Factor _____
Volume _____ <input type="checkbox"/> ac.ft.	Depth (ft) _____		
Control Structure location: _____			Dam Safety Regulations (WA State Dept of Ecology): Reservoir Volume _____ <input type="checkbox"/> cu.ft. above natural grade <input type="checkbox"/> ac.ft. Depth of Reservoir _____ (ft) above natural grade
Type of Control Structure:	No. of Orifices/Restrictions _____		
<input type="checkbox"/> Riser in vault	Size of Orifice/Restriction (in.) No.1 _____		
<input type="checkbox"/> Riser in Type II CB	(numbered starting with lowest orifice): No.2 _____		
<input type="checkbox"/> Weir in Type II CB	(inches in decimal format) No.3 _____		
		No.4 _____	

WATER QUALITY FACILITIES		Design Information	
Indicate no. of water quality facilities/BMPs for each type:		Water Quality design flow (cfs) _____	
_____ Flow dispersion		Water Quality treated volume (sandfilter) (cu.ft.) _____	
_____ Filter strip		Water Quality storage volume (wetpool) (cu.ft.) _____	
_____ Biofiltration swale <input type="checkbox"/> regular, <input type="checkbox"/> wet or		<input type="checkbox"/> Landscape management plan <input type="checkbox"/> Farm management plan	
_____ <input type="checkbox"/> continuous inflow			
_____ Wetvault <input type="checkbox"/> combined w/detention		_____ High flow bypass structure (e.g., flow-splitter catch basin)	
_____ Wetpond <input type="checkbox"/> basic <input type="checkbox"/> large <input type="checkbox"/> combined w/detention		_____ Oil/water separator <input type="checkbox"/> baffle <input type="checkbox"/> coalescing plate	
_____ Pre-settling pond		_____ Storm filter	
_____ Stormwater wetland		_____ Pre-settling structure (Manufacturer: _____)	
_____ Sand filter <input type="checkbox"/> basic <input type="checkbox"/> large		_____ Catch basin inserts (Manufacturer: _____)	
_____ <input type="checkbox"/> regular <input type="checkbox"/> linear <input type="checkbox"/> vault		_____ Source controls	
_____ Sand bed depth (inches) _____			
• Is facility lined? <input type="checkbox"/> yes <input type="checkbox"/> no		If so, what marker is used above liner? _____	
		What type of liner is used? _____	

Facility Summary Sheet Sketch: All detention, infiltration and water quality facilities must include a detailed sketch (11"x17" reduced size plan sheets preferred).

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-E
CSWPP WORKSHEET FORMS

ESC MAINTENANCE REPORT

Performed By: _____
 Date: _____
 Project Name: _____
 DPER Permit #: _____

Clearing Limits

Damage	OK _____	Problem
Visible	OK _____	Problem
Intrusions	OK _____	Problem
Other	OK _____	Problem

Mulch

Rills/Gullies	OK _____	Problem
Thickness	OK _____	Problem
Other	OK _____	Problem

Nets/Blankets

Rills/Gullies	OK _____	Problem
Ground Contact	OK _____	Problem
Other	OK _____	Problem

Plastic

Tears/Gaps	OK _____	Problem
Other	OK _____	Problem

Seeding

Percent Cover	OK _____	Problem
Rills/Gullies	OK _____	Problem
Mulch	OK _____	Problem
Other	OK _____	Problem

Sodding

Grass Health	OK _____	Problem
Rills/Gullies	OK _____	Problem
Other	OK _____	Problem

Perimeter Protection including Silt Fence

Damage	OK _____	Problem
Sediment Build-up	OK _____	Problem
Concentrated Flow	OK _____	Problem
Other	OK _____	Problem

Flow Control BMP protection

Damage	OK _____	Problem
Sedimentation	OK _____	Problem
Concentrated Flow	OK _____	Problem
Rills/Gullies	OK _____	Problem
Intrusions	OK _____	Problem
Other	OK _____	Problem

Brush Barrier

Damage	OK _____	Problem
Sediment Build-up	OK _____	Problem
Concentrated Flow	OK _____	Problem
Other	OK _____	Problem

Vegetated Strip

Damage	OK _____	Problem
Sediment Build-up	OK _____	Problem
Concentrated Flow	OK _____	Problem
Other	OK _____	Problem

Construction Entrance

Dimensions	OK _____	Problem
Sediment Tracking	OK _____	Problem
Vehicle Avoidance	OK _____	Problem
Other	OK _____	Problem

Wheel Wash		
Dimensions	OK	Problem
Sed build up or tracking	OK.....	Problem
Other	OK	Problem

Construction Road

Stable Driving Surf.	OK ____	Problem
Vehicle Avoidance	OK ____	Problem
Other	OK ____	Problem

Sediment Trap/Pond

Sed. Accumulation	OK ____	Problem
Overtopping	OK ____	Problem
Inlet/Outlet Erosion	OK ____	Problem
Other	OK ____	Problem

Catch Basin/Inlet Protection

Sed. Accumulation	OK ____	Problem
Damage	OK ____	Problem
Clogged Filter	OK ____	Problem
Other	OK ____	Problem

Interceptor Dike/Swale

Damage	OK ____	Problem
Sed. Accumulation	OK ____	Problem
Overtopping	OK ____	Problem
Other	OK ____	Problem

Pipe Slope Drain

Damage	OK ____	Problem
Inlet/Outlet	OK ____	Problem
Secure Fittings	OK ____	Problem
Other	OK ____	Problem

Ditches

Damage	OK ____	Problem
Sed. Accumulation	OK ____	Problem
Overtopping	OK ____	Problem
Other	OK ____	Problem

Outlet Protection

Scour	OK ____	Problem
Other	OK ____	Problem

Level Spreader

Damage	OK ____	Problem
Concentrated Flow	OK ____	Problem
Rills/Gullies	OK ____	Problem
Sed. Accumulation	OK ____	Problem
Other	OK ____	Problem

Dewatering Controls

Sediment	OK..	Problem
----------	------	---------

Dust Control

Palliative applied	OK	Problem
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Miscellaneous

Wet Season Stockpile	OK ____	Problem
Other	OK ____	Problem

Comments:**Actions Taken:****Problems Unresolved:**

BMP Implementation		Completed by: _____	
		Title: _____	
		Date: _____	
Develop a plan for implementing each BMP. Describe the steps necessary to implement the BMP (i.e., any construction or design), the schedule for completing those steps (list dates), and the person(s) responsible for implementation.			
BMPs	Description of Action(s) Required for Implementation	Scheduled Milestone and Completion Date(s)	Person Responsible for Action
Good Housekeeping	1.		
	2.		
	3.		
Preventive Maintenance	1.		
	2.		
	3.		
	4.		
Spill Prevention and Emergency Cleanup	1.		
	2.		
	3.		
Inspections	1.		
	2.		
	3.		

BMPs	Description of Action(s) Required for Implementation	Schedule Milestone and Completion Date(s)	Person Responsible for Action
Source Control BMPs	1.		
	2.		
	3.		
	4.		
	5.		
	6.		
	7.		
	8.		
Treatment BMPs	1.		
	2.		
	3.		
	4.		
Emerging technologies	1.		
	2.		
Flow Control BMPs	3.		
	4.		

Pollution Prevention Team	Completed by: _____ Title: _____ Date: _____
Responsible Official: _____ Team Leader: _____ Responsibilities: _____ _____ _____	Title: _____ Office Phone: _____ Cell Phone #: _____ Pager #: _____
(1) _____ Responsibilities: _____ _____ _____	Title: _____ Office Phone: _____ Pager #: _____ Cell Phone: _____
(2) _____ Responsibilities: _____ _____ _____	Title: _____ Office Phone: _____ Pager #: _____ Cell Phone #: _____

Employee Training		Completed by: _____	
		Title: _____	
		Date: _____	
Describe the annual training of employees on the SWPPP, addressing spill response, good housekeeping, and material management practices.			
Training Topics 1.) LINE WORKERS	Brief Description of Training Program/Materials (e.g., film, newsletter course)	Schedule for Training (list dates)	Attendees
Spill Prevention and Response			
Good Housekeeping			
Material Management Practices			
2.) P2 TEAM:			
SWPPP Implementation			
Monitoring Procedures			

List of Significant Spills and Leaks						Completed by: _____ Title: _____ Date: _____		
List all spills and leaks of toxic or hazardous pollutants that were significant but are <u>not</u> limited to, release of <u>oil</u> or <u>hazardous substances in excess of reportable quantities</u> . Although not required, we suggest you list spills and leaks of non-hazardous materials.								
Date (month/day/year)	Location (as indicated on site map)	Description				Response Procedure		Preventive Measure Taken
		Type of Material	Quantity	Source, If Known	Reason for Spill/Leak	Amount of Material Recovered	Material No longer exposed to Stormwater (Yes/No)	

Potential Pollutant Source Identification		Completed by: _____ Title: _____ Date: _____
List all potential stormwater pollutants from materials handled, treated, or stored on-site.		
Potential Stormwater Pollutant	Stormwater Pollutant Source	Likelihood of pollutant being present in your stormwater discharge. If yes, explain

Material Inventory		Completed by: _____ Title: _____ Date: _____							
List materials handled, treated, stored, or disposed of at the project site that may potentially be exposed to precipitation or runoff.									
Material	Purpose/Location	Quantity (Units)				Likelihood of contact with stormwater If Yes, describe reason		Past Spill or Leak	
		Used	Produced	Stored				Yes	No
		(indicate per/wk. or yr.)							

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-F
ADJUSTMENT APPLICATION AND
PROCESS GUIDELINES

REFERENCE 8-F

ADJUSTMENT PROCESS GUIDELINES AND REQUIREMENTS

1.0 PREAPPLICATION ADJUSTMENT PROCESS

SWDM 1.4 and 1.4.3. state that “Requests for standard adjustments will be accepted only for a permit pending approval or approved permits that have not yet expired.” However, there are times where the feasibility of the project is dependent upon approval of a drainage adjustment. Therefore, the King County Department of Local Services (DLS) Permitting Division (Permitting) may accept a request for a drainage adjustment if it determines that a drainage adjustment decision is needed to determine the feasibility of the project.

Requests for a drainage adjustment accepted prior to application for a development permit. are processed in the same way as that described for a standard adjustment in SWDM 1.4.3, except that a preapplication meeting is required unless waived by DLS-Permitting. The preapplication fee will be charged along with the standard adjustment fee.

If approved the drainage adjustment will be filed by DLS-Permitting until application is received for the development permit. The drainage adjustment will then be attached to the development permit. Approval conditions of the drainage adjustment shall also apply to the development permit. The drainage adjustment shall expire along with the attached development permit. Unattached drainage adjustments shall expire one year from the date the drainage adjustment was approved.

2.0 EXPERIMENTAL DESIGN ADJUSTMENT MONITORING

Water quality facilities other than those identified in Chapter 6, Reference 14-A, or Reference 14-B may be allowed on an experimental basis if it can be demonstrated that they are likely to meet the pollutant removal goal for the applicable receiving water. An experimental design adjustment is required, and monitoring is required for these.

Monitoring Requirements

For all experimental design adjustments

- All data and reports are to be submitted to King County DNRP/WLRD

Monitoring requirements for flow control facilities

- There are no Ecology or King County protocols for monitoring flow control facilities. Operations and maintenance monitoring requirements are almost certain, and flow monitoring could be required. Requirement specifics are at WLRD's discretion.

Monitoring requirements for erosion and sediment control (ESC) facilities and BMPs

- Monitoring must at a minimum duplicate CTAPE¹ protocols. Monitoring may also include operation and maintenance aspects as deemed necessary by WLRD.
- CTAPE notwithstanding, Quality Assurance Project Plan (QAPP) production, monitoring, and preparation of the Technical Evaluation Report must all be performed by an independent third party.
- CTAPE notwithstanding, the facility is to be monitored independently, i.e., results may not be pooled with results from another site to meet sample size necessary to meet statistical targets.

Monitoring requirements for facilities with WA Ecology GULD or CULD designation

- Monitoring must at a minimum duplicate TAPE¹ protocols. Monitoring may also include operation and maintenance aspects as deemed necessary by WLRD.
- TAPE notwithstanding, Quality Assurance Project Plan (QAPP) production, monitoring, and preparation of the Technical Evaluation Report must all be performed by an independent third party.
- TAPE notwithstanding, the facility is to be monitored independently, i.e., results may not be pooled with results from another site to meet sample size necessary to meet statistical targets.

Additional monitoring requirements specific to facilities with only CULD designation

- The Applicant must coordinate with WA Ecology as well as King County DNRP/WLRD.
- All data and reports are to be submitted to WA Ecology in addition to DNRP/WLRD.

3.0 FEE REDUCTION

This process is used for adjustments that are determined to meet the conditions identified below. The DLS-Permitting Director or designee shall be responsible for making the determination for a fee reduction.

¹ See <https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies> for both TAPE and CTAPE; the latter is now covered under Construction Treatment, and Approved Technologies – Construction. A WA Ecology contact is listed at the bottom of the web page.

Minor adjustment requests that are defined as issues requiring no engineering review to determine appropriateness. These include:

- New or revised standard specifications for engineering and construction which are cited in the Manual (e.g., APWA standard specifications for public works construction, WSDOT standard specifications),
- Minor design alternatives that meet the stated intent in the Manual,
- Identified errors in the Manual.

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-G

**DEDICATION AND INDEMNIFICATION
CLAUSE – FINAL RECORDING**

Sample Dedication and Indemnification Clause - Subdivision

KNOW ALL PEOPLE BY THESE PRESENTS that we, the undersigned owners of interest in the land hereby subdivided, hereby declare this plat to be the graphic representation of the subdivision made hereby, and do hereby dedicate to the use of the public forever all streets and avenues not shown as private hereon and dedicate the use thereof for all public purposes not inconsistent with the use thereof for public highway purposes, and also the right to make all necessary slopes for cuts and fills upon the lots shown thereon in the original reasonable grading of said streets and avenues, and further dedicate to the use of the public all the easements and tracts shown on this plat for all public purposes as indicated thereon, including but not limited to parks, open space, utilities and drainage unless such easements or tracts are specifically identified on this plat as being dedicated or conveyed to a person or entity other than the public, in which case we do hereby dedicate such streets, easements, or tracts to the person or entity identified and for the purpose stated.

Further, the undersigned owners of the land hereby subdivided, waive for themselves, their heirs and assigns and any person or entity deriving title from the undersigned, any and all claims for damages against King County, its successors and assigns which may be occasioned by the establishment, construction, or maintenance of roads and/or drainage systems within this subdivision other than claims resulting from inadequate maintenance by King County.

Further, the undersigned owners of the land hereby subdivided, agree for themselves, their heirs and assigns to indemnify and hold King County, its successors and assigns, harmless from any damage, including any costs of defense, claimed by persons within or without this subdivision to have been caused by alterations of the ground surface, vegetation, drainage, or surface or sub-surface water flows within this subdivision or by establishment, construction or maintenance of the roads within this subdivision. Provided, this waiver and indemnification shall not be construed as releasing King County, its successors or assigns, from liability for damages, including the cost of defense, resulting in whole or in part from the negligence of King County, its successors, or assigns.

This subdivision, dedication, waiver of claims and agreement to hold harmless is made with the free consent and in accordance with the desires of said owners.

IN WITNESS WHEREOF we set our hands and seals.

Name

Name

Name

Name

Name

Name

State of Washington
County of _____

I certify that I know or have satisfactory evidence that

Signed the instrument and acknowledged it to be (his/her) free and voluntary act for the uses and purposes mentioned in the instrument.

Sample Dedication and Indemnification Clause – Short Subdivision

KNOW ALL PEOPLE BY THESE PRESENTS that we, the undersigned owners of interest in the land hereby short subdivided, hereby declare this short plat to be the graphic representation of the short subdivision made hereby, and do hereby dedicate to the use of the public forever all streets and avenues not shown as private hereon and dedicate the use thereof for all public purposes not inconsistent with the use thereof for public highway purposes, and also the right to make all necessary slopes for cuts and fills upon the lots shown thereon in the original reasonable grading of said streets and avenues, and further dedicate to the use of the public all the easements and tracts shown on this plat for all public purposes as indicated thereon, including but not limited to parks, open space, utilities and drainage unless such easements or tracts are specifically identified on this plat as being dedicated or conveyed to a person or entity other than the public, in which case we do hereby dedicate such streets, easements, or tracts to the person or entity identified and for the purpose stated.

Further, the undersigned owners of the land hereby short subdivided, waive for themselves, their heirs and assigns and any person or entity deriving title from the undersigned, any and all claims for damages against King County, its successors and assigns which may be occasioned by the establishment, construction, or maintenance of roads and/or drainage systems within this short subdivision other than claims resulting from inadequate maintenance by King County.

Further, the undersigned owners of the land hereby short subdivided, agree for themselves, their heirs and assigns to indemnify and hold King County, its successors and assigns, harmless from any damage, including any costs of defense, claimed by persons within or without this short subdivision to have been caused by alterations of the ground surface, vegetation, drainage, or surface or sub-surface water flows within this short subdivision or by establishment, construction or maintenance of the roads within this short subdivision. Provided, this waiver and indemnification shall not be construed as releasing King County, its successors or assigns, from liability for damages, including the cost of defense, resulting in whole or in part from the negligence of King County, its successors, or assigns.

This subdivision, dedication, waiver of claims and agreement to hold harmless is made with the free consent and in accordance with the desires of said owners.

IN WITNESS WHEREOF we set our hands and seals.

Name

Name

Name

Name

Name

Name

State of Washington
County of _____

I certify that I know or have satisfactory evidence that

Signed the instrument and acknowledged it to be (his/her) free and voluntary act for the uses and purposes mentioned in the instrument.

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-H
BOND QUANTITIES WORKSHEET

See the current version at:

[DLS-Permitting \(see kingcounty.gov/depts/local-services/permits/infosheets-forms/permit-application-forms-title.#S](https://kingcounty.gov/depts/local-services/permits/infosheets-forms/permit-application-forms-title.#S) .

Select “Site Improvement Bond Quantity Worksheet”

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-I
MAINTENANCE AND DEFECT
AGREEMENT

For the current version, contact the Financial Guarantees Management Unit at the King County Department of Local Services, Permitting Division at (206) 296-6600 and FGMU.DDES@kingcounty.gov.

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-J
DECLARATION OF COVENANT

RECORDING REQUESTED BY AND
WHEN RECORDED MAIL TO:

**DECLARATION OF COVENANT
FOR INSPECTION AND MAINTENANCE OF STORMWATER
FACILITIES AND BMPS**

Grantor: _____

Grantee: King County

Legal Description: _____

Additional Legal(s) on: _____

Assessor's Tax Parcel ID#: _____

IN CONSIDERATION of the approved King County _____ permit
for application No. _____ relating to the real property ("Property") described
above, the Grantor(s), the owner(s) in fee of that Property, hereby covenants(covenant) with King County,
a political subdivision of the state of Washington and its municipal successors in interest and assigns
("King County" and "the County", or "its municipal successor"), that he/she(they) will observe, consent
to, and abide by the conditions and obligations set forth and described in Paragraphs 1 through 10 below

with regard to the Property, and hereby grants(grant) an easement as described in Paragraphs 2 and 3.

Grantor(s) hereby grants(grant), covenants(covenant), and agrees(agree) as follows:

1. The Grantor(s) or his/her(their) successors in interest and assigns ("Owners") shall at their own cost, operate, maintain, and keep in good repair, the Property's stormwater facilities and best management practices ("BMPs") identified in the plans and specifications submitted to King County for the review and approval of permit(s) #: _____. Stormwater facilities include pipes, swales, tanks, vaults, ponds, and other engineered structures designed to manage stormwater on the Property. Stormwater BMPs include dispersion and infiltration devices, native vegetated areas, permeable pavements, vegetated roofs, rainwater harvesting systems, reduced impervious surface coverage, and other measures designed to reduce the amount of stormwater runoff on the Property.

2. King County shall have the right to ingress and egress over those portions of the Property necessary to perform inspections of the stormwater facilities and BMPs and conduct other activities specified in this Declaration of Covenant and in accordance with King County Code ("KCC") 9.04.120 or relevant municipal successor's codes as applicable. This right of ingress and egress, right to inspect, and right to perform required maintenance or repair as provided for in Section 3 below, shall not extend over those portions of the Property shown in Exhibit "A."

3. If King County determines that maintenance or repair work is required to be done to any of the stormwater facilities or BMPs, the Director of the Water and Land Resources Division or its municipal successor in interest ("WLR") shall give notice of the specific maintenance and/or repair work required pursuant to KCC 9.04.120 or relevant municipal successor's codes as applicable. The Director shall also set a reasonable time in which such work is to be completed by the Owners. If the above required maintenance or repair is not completed within the time set by the Director, the County may perform the required maintenance or repair, and hereby is given access to the Property, subject to the exclusion in Paragraph 2 above, for such purposes. Written notice will be sent to the Owners stating the County's intention to perform such work. This work will not commence until at least seven (7) days after such

notice is mailed. If, within the sole discretion of the WLR Director, there exists an imminent or present danger, the seven (7) day notice period will be waived and maintenance and/or repair work will begin immediately.

4. If at any time King County reasonably determines that a stormwater facility or BMP on the Property creates any of the hazardous conditions listed in KCC 9.04.130 or relevant municipal successor's codes as applicable and herein incorporated by reference, the WLR Director or equivalent municipal successors official may take measures specified therein.

5. The Owners shall assume all responsibility for the cost of any maintenance or repair work completed by the County as described in Paragraph 3 or any measures taken by the County to address hazardous conditions as described in Paragraph 4. Such responsibility shall include reimbursement to the County within thirty (30) days of the receipt of the invoice for any such work performed. Overdue payments will require payment of interest at the current legal rate as liquidated damages. If legal action ensues, the prevailing party is entitled to costs or fees.

6. The Owners are hereby required to obtain written approval from the King County WLR Director prior to filling, piping, cutting, or removing vegetation (except in routine landscape maintenance) in open vegetated stormwater facilities (such as swales, channels, ditches, ponds, etc.), or performing any alterations or modifications to the stormwater facilities and BMPs referenced in this Declaration of Covenant.

7. Any notice or consent required to be given or otherwise provided for by the provisions of this Agreement shall be effective upon personal delivery, or three (3) days after mailing by Certified Mail, return receipt requested.

8. With regard to the matters addressed herein, this agreement constitutes the entire agreement between the parties, and supersedes all prior discussions, negotiations, and all agreements whatsoever whether oral or written.

9. This Declaration of Covenant is intended to protect the value and desirability of the real property described above, and shall inure to the benefit of all the citizens of King County and its

municipal successors and assigns. This Declaration of Covenant shall run with the land and be binding upon Grantor(s), and Grantor's(s') successors in interest, and assigns.

10. This Declaration of Covenant may be terminated by execution of a written agreement by the Owners and King County or the municipal successor that is recorded by King County in its real property records.

IN WITNESS WHEREOF, this Declaration of Covenant for the Inspection and Maintenance of Stormwater Facilities and BMPs is executed this ____ day of _____, 20____.

GRANTOR, owner of the Property

GRANTOR, owner of the Property

STATE OF WASHINGTON)
COUNTY OF KING)ss.

On this day personally appeared before me:

_____, to me known to be the individual(s) described in and who executed the within and foregoing instrument and acknowledged that they signed the same as their free and voluntary act and deed, for the uses and purposes therein stated.

Given under my hand and official seal this ____ day of _____, 20____.

Printed name
Notary Public in and for the State of Washington,
residing at

My appointment expires _____

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-K
DRAINAGE RELEASE COVENANT

RECORDING REQUESTED BY AND
WHEN RECORDED MAIL TO:

DECLARATION OF COVENANT FOR DRAINAGE RELEASE

Grantor: _____

Grantee: King County

Legal Description: _____

Additional Legal(s) on: _____

Assessor's Tax Parcel ID#: _____

THIS DECLARATION OF COVENANT FOR DRAINAGE RELEASE is made by and between Grantor and Grantee.

WHEREAS, the Grantor(s) represents(represent) and warrants(warrant) that he/she(they) is(are) the owner(s) in fee of that certain parcel of land, described above, and

WHEREAS, King County, a political subdivision of the State of Washington, is implementing an approved drainage plan for the project known as _____, permit no. _____, on lands located at the above description, which said plan shall divert surface and storm waters from their natural course and cause them to flow (onto)/(away from) the lands of Grantor(s);

NOW THEREFORE, in consideration of either Grantee approval of diversion by said plan and/or other valuable consideration, receipt of which is hereby acknowledged, the Grantor hereby willfully acknowledges, agrees, and consents to the diversion of surface and storm waters (onto)/(away from) its lands and to hold and release Grantee harmless for any damage that may be caused by such diversion of flow. This release shall be a covenant running with the land and shall be binding upon the Grantee, its heirs, successors, and assigns forever.

IN WITNESS WHEREOF, this Declaration of Covenant for Drainage Release is executed this _____ day of _____, 20____.

GRANTOR, owner of the Property

GRANTOR, owner of the Property

STATE OF WASHINGTON)
COUNTY OF KING)ss.

On this day personally appeared before me:

_____, to me known to be the individual(s) described in and who executed the within and foregoing instrument and acknowledged that they signed the same as their free and voluntary act and deed, for the uses and purposes therein stated.

Given under my hand and official seal this _____ day of _____, 20____.

Printed name
Notary Public in and for the State of Washington,
residing at

My appointment expires _____

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-L
DRAINAGE EASEMENT

RECORDING REQUESTED BY AND
WHEN RECORDED MAIL TO:

DRAINAGE EASEMENT

Grantor: _____

Grantee: King County

Legal Description: _____

Additional Legal(s) on: _____

Assessor's Tax Parcel ID#: _____

FOR A VALUABLE CONSIDERATION, receipt of which is hereby acknowledged, the Grantor(s), the owner(s) in fee of that certain parcel of land, described above, hereby grant and convey a(an) [exclusive/non-exclusive] easement (attached and incorporated as Exhibit "A") to Grantee, King County, a political subdivision of the state of Washington and its municipal successors in interest and assigns ("King County" and "the County", or "its municipal successor"), for the purpose of conveying, storing, managing, and facilitating surface and storm water per an engineering plan approved by King County for the project known as: _____

together with the right for King County to enter said drainage easement at reasonable times for the purpose of inspecting, operating, maintaining, repairing, and improving the drainage facilities contained herein. Note that except for facilities which have been formally accepted for maintenance by King County, maintenance and repair of drainage facilities on private property is the responsibility of the property owner.

The Grantor(s) of said parcel is (are) required to obtain prior written approval from the Water and Land Resources Division of the King County Department of Natural Resources prior to filling, piping, cutting, or removing vegetation (except for routine landscape maintenance such as lawn mowing) in open vegetated drainage facilities (such as swales, channels, ditches, ponds, etc.), or performing any alterations or modifications to the drainage facilities, contained within said drainage easement.

This easement is intended to facilitate reasonable access to the drainage facilities. It is binding upon the Grantor(s), its heirs, successors, and assigns.

IN WITNESS WHEREOF, this Drainage Easement is executed this ____ day of _____, 20____.

GRANTOR, owner of the Property

GRANTOR, owner of the Property

STATE OF WASHINGTON)
COUNTY OF KING)ss.

On this day personally appeared before me:

_____, to me known to be the individual(s) described in and who executed the within and foregoing instrument and acknowledged that they signed the same as their free and voluntary act and deed, for the uses and purposes therein stated.

Given under my hand and official seal this ____ day of _____, 20____.

Printed name
Notary Public in and for the State of Washington,
residing at

My appointment expires _____

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-M

**FLOW CONTROL BMP DECLARATION
OF COVENANT AND GRANT OF
EASEMENT**

**BMP MAINTENANCE INSTRUCTIONS
(RECORDABLE FORMAT)**

RECORDING REQUESTED BY AND
WHEN RECORDED MAIL TO:

DECLARATION OF COVENANT FOR MAINTENANCE AND INSPECTION OF FLOW CONTROL BMPS

Grantor: _____

Grantee: King County

Legal Description: _____

Additional Legal(s) on: _____

Assessor's Tax Parcel ID#: _____

IN CONSIDERATION of the approved King County (check one of the following) ☐ residential building permit, ☐ commercial building permit, ☐ clearing and grading permit, ☐ subdivision permit, or ☐ short subdivision permit for Application No. _____ relating to the real property ("Property") described above, the Grantor(s), the owner(s) in fee of that Property, hereby covenants(covenant) with King County, a political subdivision of the state of Washington, and its municipal successors in interest and assigns ("King County" and "the County", or "its municipal successor"), that he/she(they) will observe, consent to, and abide by the conditions and obligations set forth and described in Paragraphs 1 through 8 below with regard to the Property. Grantor(s) hereby grants(grant), covenants(covenant), and agrees(agree) as follows:

1. Grantor(s) or his/her(their) successors in interest and assigns ("Owners") shall retain, uphold, and protect the stormwater management devices, features, pathways, limits, and restrictions, known as flow control best management practices ("BMPs"), shown on the approved Flow Control BMP Site Plan for the Property attached hereto and incorporated herein as Exhibit A.

2. The Owners shall at their own cost, operate, maintain, and keep in good repair, the Property's BMPs as described in the approved Design and Maintenance Details for each BMP attached hereto and incorporated herein as Exhibit B.

3. King County shall provide at least 30 days written notice to the Owners that entry on the Property is planned for the inspection of the BMPs. After the 30 days, the Owners shall allow King County to enter for the sole purpose of inspecting the BMPs. In lieu of inspection by the County, the Owners may elect to engage a licensed civil engineer registered in the state of Washington who has expertise in drainage to inspect the BMPs and provide a written report describing their condition. If the engineer option is chosen, the Owners shall provide written notice to the Director of the Water and Land Resources Division or its municipal successor in interest ("WLR") within fifteen days of receiving the County's notice of inspection. Within 30 days of giving this notice, the Owners, or the engineer on behalf of the Owners, shall provide the engineer's report to WLR. If the report is not provided in a timely manner as specified above, the County may inspect the BMPs without further notice.

4. If King County determines from its inspection, or from an engineer's report provided in accordance with Paragraph 3, that maintenance, repair, restoration, and/or mitigation work is required for the BMPs, WLR shall notify the Owners of the specific maintenance, repair, restoration, and/or mitigation work (Work) required under Title 9 of the King County Code ("KCC"). WLR shall also set a reasonable deadline for completing the Work or providing an engineer's report that verifies completion of the Work. After the deadline has passed, the Owners shall allow the County access to re-inspect the BMPs unless an engineer's report has been provided verifying completion of the Work. If the work is not completed properly within the time frame set by WLR, King County may initiate an enforcement action. Failure to

properly maintain the BMPs is a violation of KCC Chapter 9.04 and may subject the Owners to enforcement under the KCC, including fines and penalties.

5. Apart from performing routine landscape maintenance, the Owners are hereby required to obtain written approval from WLR before performing any alterations or modifications to the BMPs.

6. Any notice or approval required to be given by one party to the other under the provisions of this Declaration of Covenant shall be effective upon personal delivery to the other party, or after three (3) days from the date that the notice or approval is mailed with delivery confirmation to the current address on record with each Party. The parties shall notify each other of any change to their addresses.

7. This Declaration of Covenant is intended to promote the efficient and effective management of surface water drainage on the Property, and it shall inure to the benefit of all the citizens of King County and its municipal successors and assigns. This Declaration of Covenant shall run with the land and be binding upon Grantor(s), and Grantor's(s') successors in interest and assigns.

8. This Declaration of Covenant may be terminated by execution of a written agreement by the Owners and King County that is recorded by King County in its real property records.

IN WITNESS WHEREOF, this Declaration of Covenant for the Maintenance and Inspection of
Flow Control BMPs is executed this _____ day of _____, 20____.

GRANTOR, owner of the Property

GRANTOR, owner of the Property

STATE OF WASHINGTON)
COUNTY OF KING)ss.

On this day personally appeared before me:

_____, to me known to be the individual(s) described in
and who executed the within and foregoing instrument and acknowledged that they signed the same as
their free and voluntary act and deed, for the uses and purposes therein stated.

Given under my hand and official seal this _____ day of _____, 20____.

Printed name
Notary Public in and for the State of Washington,
residing at

My appointment expires _____

MAINTENANCE INSTRUCTIONS FOR FULL DISPERSION

Your property contains a stormwater management flow control BMP (best management practice) called "*full dispersion*."

Full dispersion is a strategy for minimizing the area disturbed by development (i.e., impervious or non-native pervious surfaces, such as concrete areas, roofs, and lawns) relative to native vegetated areas (e.g., forested surface) together with the application of dispersion techniques that utilize the natural capacity of the native vegetated areas to mitigate the stormwater runoff quantity and quality impacts of the developed surfaces.

This flow control BMP has two primary components that must be maintained:

- (1) the devices that disperse runoff from the developed surfaces, and
- (2) the native vegetated area and flowpath receiving the dispersed runoff.

Dispersion Devices

The **dispersion devices** used on your property include the following as indicated on the flow control BMP site plan (CHECK THE BOX(ES) THAT APPLY):

- ☐ splash blocks, ☐ rock pads, ☐ gravel filled trenches, ☐ sheet flow.

MAINTENANCE RESTRICTIONS

The size, placement, composition, and downstream flowpaths of these devices as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.

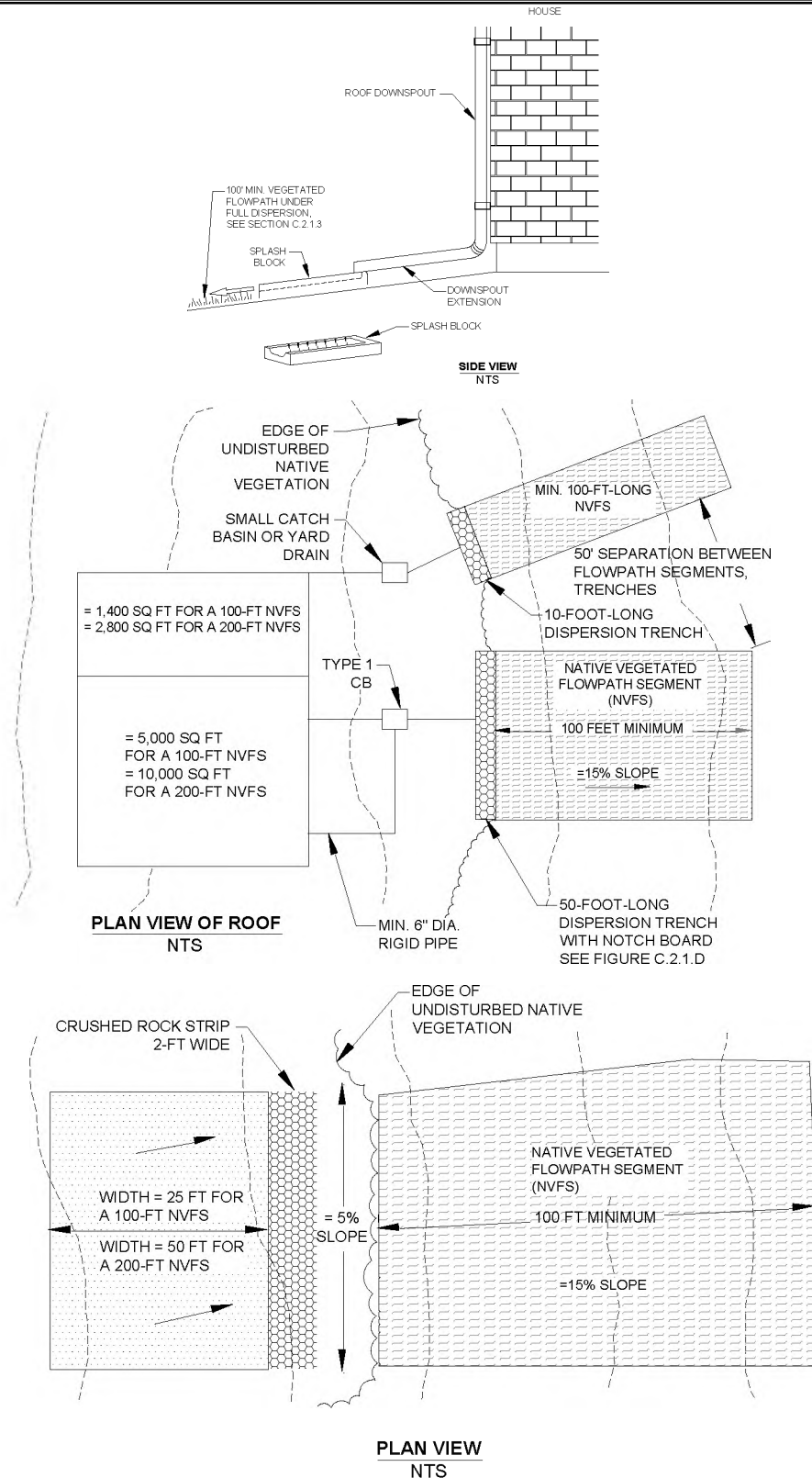
INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Dispersion devices must be inspected annually and after major storm events to identify and repair any physical defects.
- When native soil is exposed or erosion channels are present, the sources of the erosion or concentrated flow need to be identified and mitigated.
- Bare spots should be re-vegetated with native vegetation.
- Concentrated flow can be mitigated by leveling the edge of the pervious area and/or regrading or replenishing the rock in the dispersion device, such as in rock pads and gravel-filled trenches.

RECORDING REQUIREMENT

These full dispersion flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

TYPICAL FULL DISPERSION APPLICATIONS



MAINTENANCE INSTRUCTIONS FOR FULL INFILTRATION

Your property contains a stormwater management flow control BMP (best management practice) called "**full infiltration**," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious surfaces on your property.

Full infiltration is a method of soaking runoff from impervious area (such as paved areas and roofs) into the ground. If properly installed and maintained, full infiltration can manage runoff so that a majority of precipitation events are absorbed. Infiltration devices, such as gravel filled trenches, drywells, and ground surface depressions, facilitate this process by putting runoff in direct contact with the soil and holding the runoff long enough to soak most of it into the ground. To be successful, the soil condition around the infiltration device must be reliably able to soak water into the ground for a reasonable number of years.

Infiltration Devices

The **infiltration devices** used on your property include the following as indicated on the flow control BMP site plan (CHECK THE BOX(ES) THAT APPLY):

☐ gravel filled trenches, ☐ drywells, ☐ ground surface depressions.

MAINTENANCE RESTRICTIONS

The size, placement, and composition of these devices as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

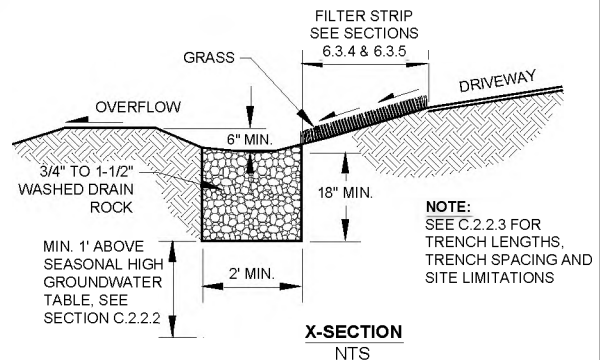
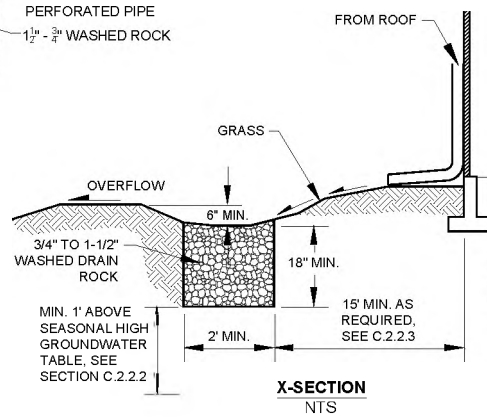
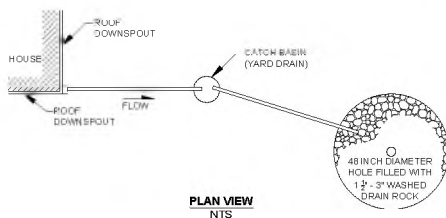
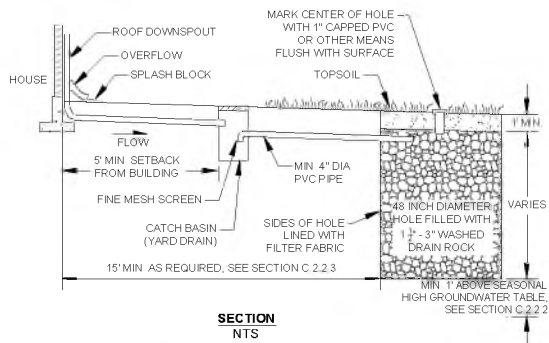
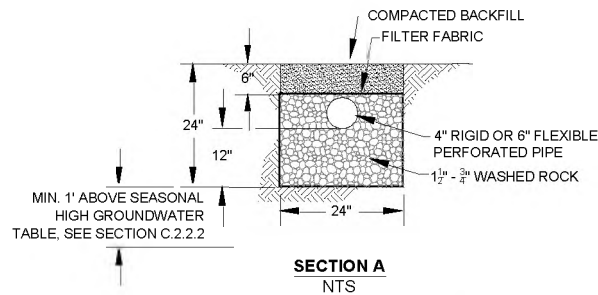
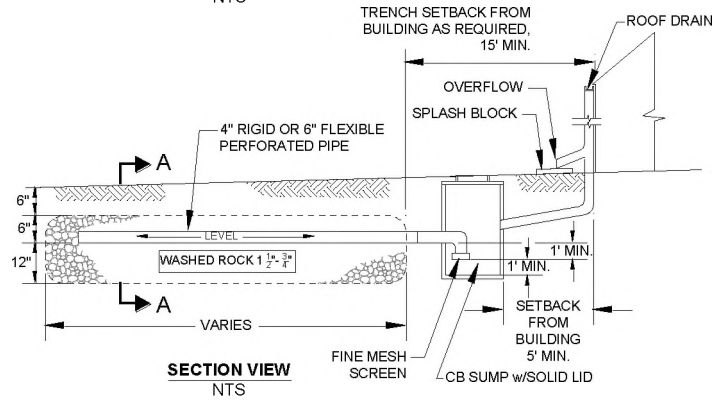
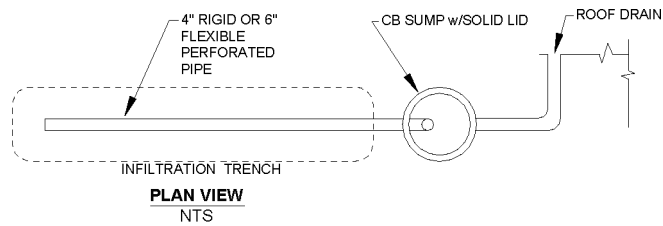
To be successful, the soil condition around the infiltration device must be reliably able to soak water into the ground for a reasonable number of years.

- Infiltration devices must be inspected annually and after major storm events to identify and repair any physical defects.
- Maintenance and operation of the system should focus on ensuring the system's viability by preventing sediment-laden flows from entering the device. Excessive sedimentation will result in a plugged or non-functioning facility.
- If the infiltration device has a catch basin, sediment accumulation must be removed on a yearly basis or more frequently if necessary.
- Prolonged ponding around or atop a device may indicate a plugged facility. If the device becomes plugged, it must be replaced.
- Keeping the areas that drain to infiltration devices well swept and clean will enhance the longevity of these devices.
- For roofs, frequent cleaning of gutters will reduce sediment loads to these devices.

RECORDING REQUIREMENT

These full infiltration flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

TYPICAL FULL INFILTRATION APPLICATIONS



NOTE:
SEE C.2.2.3 FOR
TRENCH LENGTHS,
TRENCH SPACING AND
SITE LIMITATIONS

MAINTENANCE INSTRUCTIONS FOR A RAIN GARDEN

Your property contains a stormwater management flow control BMP (best management practice) called a "*rain garden*," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious or non-native pervious surfaces on your property.

Rain gardens, often described as "bioretention," are vegetated closed depressions or ponds that retain and filter stormwater from an area of impervious surface or non-native pervious surface. The soil in the rain garden has been enhanced to encourage and support vigorous plant growth that serves to filter the water and sustain infiltration capacity. Depending on soil conditions, rain gardens may have water in them throughout the wet season and may overflow during major storm events.

MAINTENANCE RESTRICTIONS

The size, placement, and design of the rain garden as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County. Plant materials may be changed to suit tastes, but chemical fertilizers and pesticides must not be used.

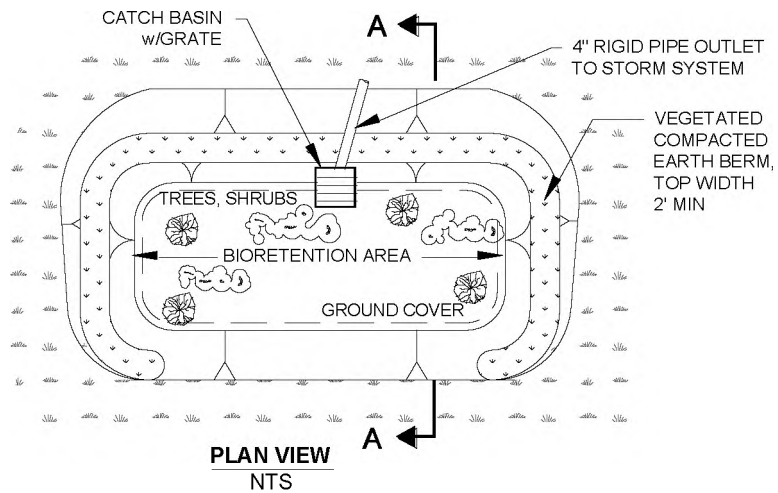
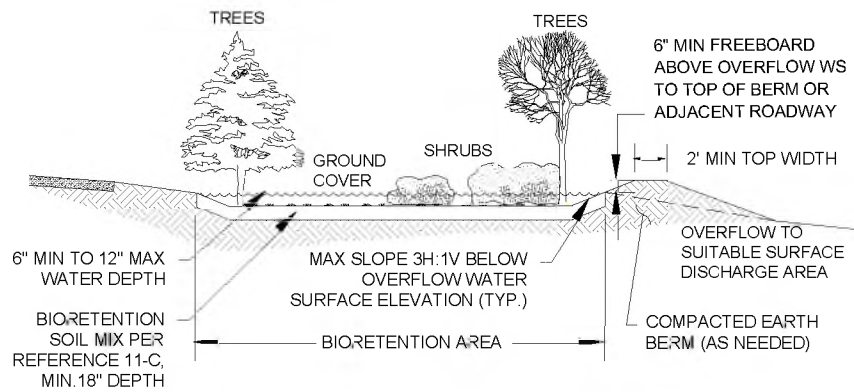
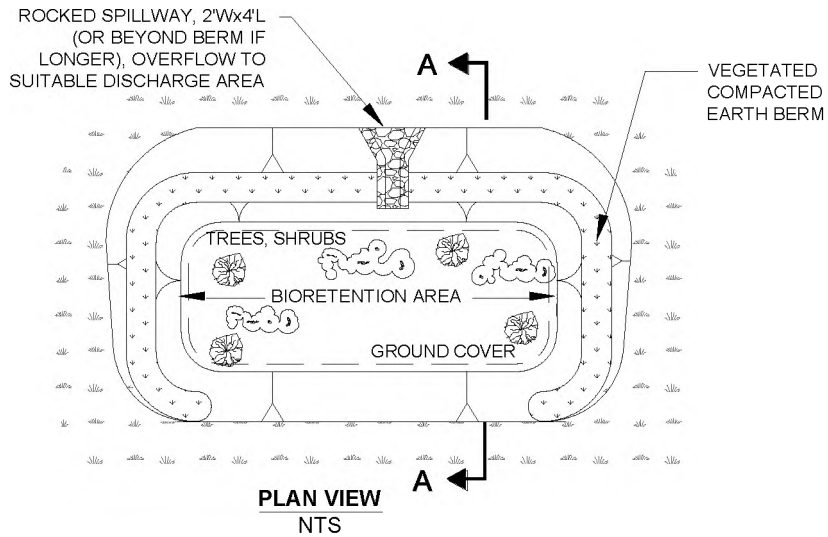
INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Rain gardens must be inspected annually for physical defects and sediment accumulation.
- After major storm events, the system should be checked to see that the overflow system is working properly and sedimentation is not occurring at the inlet. If erosion channels or bare spots are evident, they should be stabilized with soil, plant material, mulch, or landscape rock. Sediment deposits should be carefully removed and the sediment source eliminated.
- A supplemental watering program may be needed the first year to ensure the long-term survival of the rain garden's vegetation.
- Chemical fertilizers and pesticides must not be used.
- Mulch may be added and additional compost should be worked into the soil over time. At minimum, compost and compost mulch must comply with feedstock disallowances contained in Reference 11-C.1.A, #3.
- Plant materials may be changed to suit tastes.
- Vegetation should be maintained as follows:
 - 1) replace all dead vegetation as soon as possible;
 - 2) remove fallen leaves and debris as needed;
 - 3) remove all noxious vegetation when discovered;
 - 4) manually weed without herbicides or pesticides;
 - 5) to protect infiltration performance, do not compact soils in the bioretention cell with heavy maintenance equipment and/or excessive foot traffic;
 - 6) during drought conditions, use mulch to prevent excess solar damage and water loss.

RECORDING REQUIREMENT

These rain garden flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

TYPICAL RAIN GARDEN (SPILLWAY OR CATCHBASIN OUTLET)



MAINTENANCE INSTRUCTIONS FOR A BIORETENTION CELL

Your property contains a stormwater management flow control BMP (best management practice) called "*bioretention*," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious or non-native pervious surfaces on your property.

Bioretention cells, like rain gardens, are vegetated closed depressions or ponds that retain and filter stormwater from an area of impervious surface or non-native pervious surface. Bioretention cells rely on effective infiltration performance more so than rain gardens. The soil in the bioretention cell has been enhanced to encourage and support vigorous plant growth that serves to filter the water and sustain a minimum infiltration capacity. Depending on soil conditions, bioretention cells may have water in them throughout the wet season and may overflow during major storm events. However, standing water can also be an indicator that periodic maintenance is required to sustain infiltrative performance.

MAINTENANCE RESTRICTIONS

The size, placement, and design of the rain garden as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County. Plant materials may be changed to suit tastes, but chemical fertilizers and pesticides must not be used.

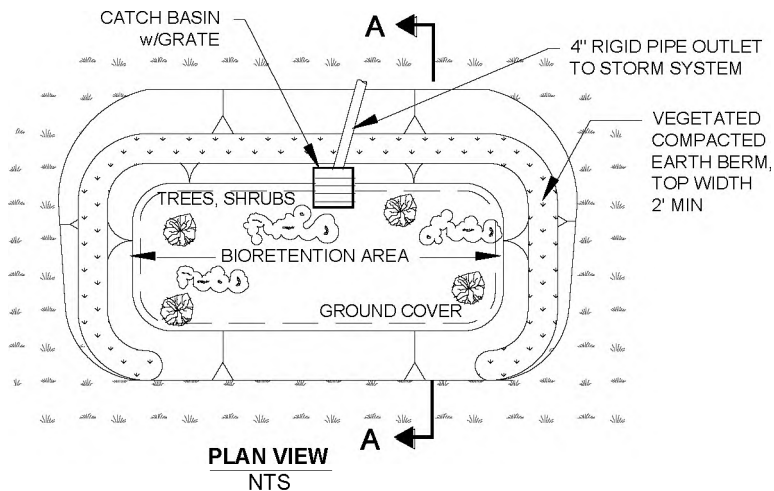
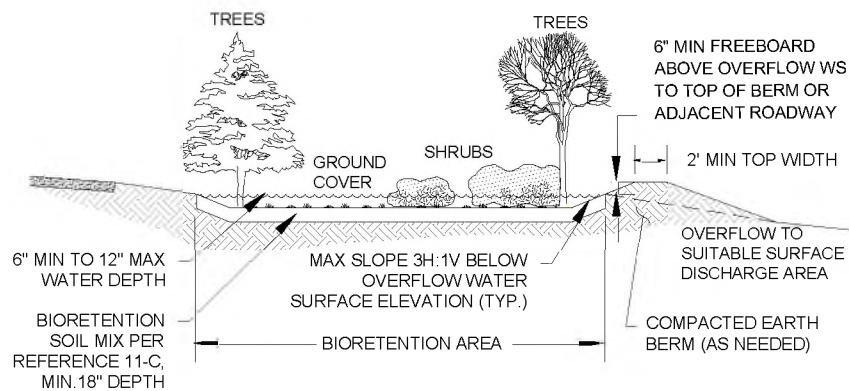
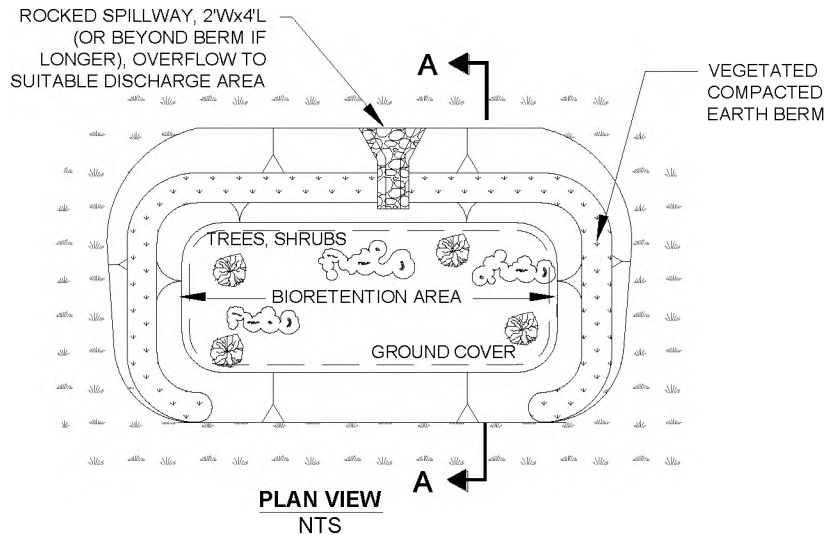
INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Bioretention cells must be inspected annually for physical defects and sediment accumulation.
- After major storm events, the system should be checked to see that the overflow system is working properly and sedimentation is not occurring at the inlet. If erosion channels or bare spots are evident, they should be stabilized with soil, plant material, mulch, or landscape rock. Sediment deposits should be carefully removed and the sediment source eliminated.
- A supplemental watering program may be needed the first year to ensure the long-term survival of the bioretention cells' vegetation.
- Chemical fertilizers and pesticides must not be used.
- Mulch may be added and additional compost should be worked into the soil over time. Mulch must comply with Reference 11-C.3 specification for "Bioretention Mulch". Compost must comply with Reference 11-C.2.B "Bioretention Compost".
- Plant materials may be changed to suit tastes.
- Vegetation should be maintained as follows:
 - 1) replace all dead vegetation as soon as possible;
 - 2) remove fallen leaves and debris as needed;
 - 3) remove all noxious vegetation when discovered;
 - 4) manually weed without herbicides or pesticides;
 - 5) to protect infiltration performance, do not compact soils in the bioretention cell with heavy maintenance equipment and/or excessive foot traffic;
 - 6) during drought conditions, use mulch to prevent excess solar damage and water loss.

RECORDING REQUIREMENT

These bioretention flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

TYPICAL BIORETENTION CELL (SPILLWAY OR CATCHBASIN OUTLET)



MAINTENANCE INSTRUCTIONS FOR VEGETATED PERMEABLE PAVEMENT (GRASSED MODULAR GRID PAVEMENT)

Your property contains a stormwater management flow control BMP (best management practice) called "*grassed modular grid pavement*," which was installed to minimize the stormwater quantity and quality impacts of some or all of the paved surfaces on your property.

Grassed modular grid pavement has the runoff characteristics of a lawn while providing the weight-bearing capacity of concrete pavement. The grassed surface not only minimizes runoff quantity, it helps to filter pollutants generating by vehicular use of the surface.

MAINTENANCE RESTRICTIONS

The composition and area of grassed modular grid pavement as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Grassed modular grid pavement must be inspected after one major storm each year to make sure it is working properly. More frequent inspection is recommended.
- Prolonged ponding or standing water on the pavement surface is a sign that the system is defective and may need to be replaced. If this occurs, or if any modification, surface restoration or stabilization is planned (except for mowing and periodic maintenance), contact the pavement installer or the King County Water and Land Resources Division for further instructions.
- The grassed surface of the pavement must be regularly mowed and maintained in a good condition. Bare spots must be replanted in the spring or fall.

RECORDING REQUIREMENT

These vegetated permeable pavement flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Permitting and Environmental Services (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

MAINTENANCE INSTRUCTIONS FOR PERMEABLE PAVEMENT (NON-VEGETATED)

Your property contains a stormwater management flow control BMP (best management practice) called "*permeable pavement*," which was installed to minimize the stormwater quantity and quality impacts of some or all of the paved surfaces on your property.

Permeable pavements reduce the amount of rainfall that becomes runoff by allowing water to seep through the pavement into a free-draining gravel or sand bed, where it can be infiltrated into the ground.

Permeable Pavements

The type(s) of **permeable pavement** used on your property is (CHECK THE BOX(ES) THAT APPLY):

- ☐ porous concrete
- ☐ porous asphaltic concrete
- ☐ permeable pavers
- ☐ modular grid pavement.

MAINTENANCE RESTRICTIONS

The area covered by permeable pavement as depicted by the flow control BMP site plan and design details must be maintained as permeable pavement and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Permeable pavements must be inspected after one major storm each year to make sure it is working properly. More frequent inspection is recommended.
- Prolonged ponding or standing water on the pavement surface is a sign that the system is defective and may need to be replaced. If this occurs, contact the pavement installer or the King County Water and Land Resources Division for further instructions.
- A typical permeable pavement system has a life expectancy of approximately 25-years. To help extend the useful life of the system, the surface of the permeable pavement should be kept clean, stable and free of leaves, debris, and sediment through regular sweeping or vacuum sweeping. Aggregate fill in modular grid pavement may need periodic surface replenishment.
- The owner is responsible for the repair of all ruts, deformation, and/or broken paving units.

RECORDING REQUIREMENT

These permeable pavement flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

MAINTENANCE INSTRUCTIONS FOR BASIC DISPERSION

Your property contains a stormwater management flow control BMP (best management practice) called "*basic dispersion*," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious surfaces or non-native pervious surfaces on your property.

Basic dispersion is a strategy for utilizing any available capacity of onsite vegetated areas to retain, absorb, and filter the runoff from developed surfaces. This flow control BMP has two primary components that must be maintained:

- (1) the devices that disperse runoff from the developed surfaces and
- (2) the vegetated area over which runoff is dispersed.

Dispersion Devices

The **dispersion devices** used on your property include the following as indicated on the flow control BMP site plan (CHECK THE BOX(ES) THAT APPLY):

☐ splash blocks, ☐ rock pads, ☐ gravel filled trenches, ☐ sheet flow.

MAINTENANCE RESTRICTIONS

The size, placement, composition, and downstream flowpaths of these devices as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

This flow control BMP has two primary components that must be maintained:

- (1) the devices that disperse runoff from the developed surfaces and
- (2) the vegetated flowpath area over which runoff is dispersed.

Maintenance of Dispersion Devices

- Dispersion devices must be inspected annually and after major storm events to identify and repair any physical defects.
- When native soil is exposed or erosion channels are present, the sources of the erosion or concentrated flow need to be identified and mitigated.
- Concentrated flow can be mitigated by leveling the edge of the pervious area and/or realigning or replenishing the rocks in the dispersion device, such as in rock pads and gravel filled trenches.

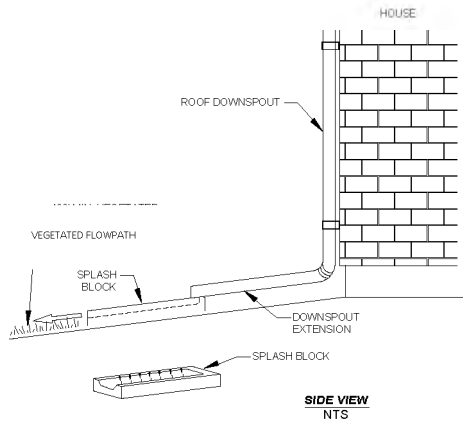
Maintenance of Vegetated Flowpaths

- The vegetated area over which runoff is dispersed must be maintained in good condition free of bare spots and obstructions that would concentrate flows.

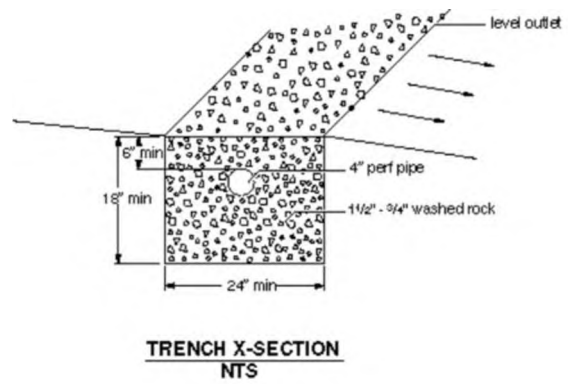
RECORDING REQUIREMENT

These basic dispersion flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

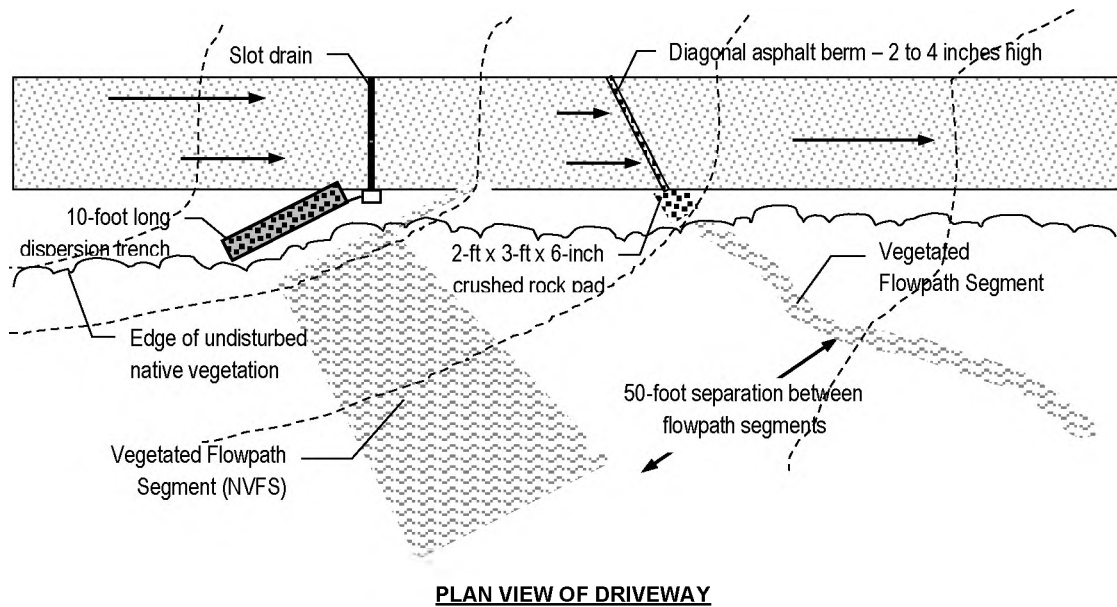
TYPICAL SPLASH BLOCK



TYPICAL 10-FOOT DISPERSION TRENCH CROSS-SECTION



TYPICAL DRIVEWAY APPLICATION OF DISPERSION TRENCH AND ROCK PAD



MAINTENANCE INSTRUCTIONS FOR LIMITED INFILTRATION

Your property contains a stormwater management flow control BMP (best management practice) called "**limited infiltration**," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious surfaces on your property.

Limited infiltration is a method of soaking runoff from impervious area (such as paved areas and roofs) into the ground. Infiltration devices, such as gravel filled trenches, drywells, and ground surface depressions, facilitate this process by putting runoff in direct contact with the soil and holding the runoff long enough to soak most of it into the ground. To be successful, the soil condition around the infiltration device must be able to soak water into the ground for a reasonable number of years.

Infiltration Devices

The **infiltration devices** used on your property include the following as indicated on the flow control BMP site plan (CHECK THE BOX(ES) THAT APPLY):

- ☐ gravel filled trenches, ☐ drywells.

MAINTENANCE RESTRICTIONS

The size, placement, and composition of these devices as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

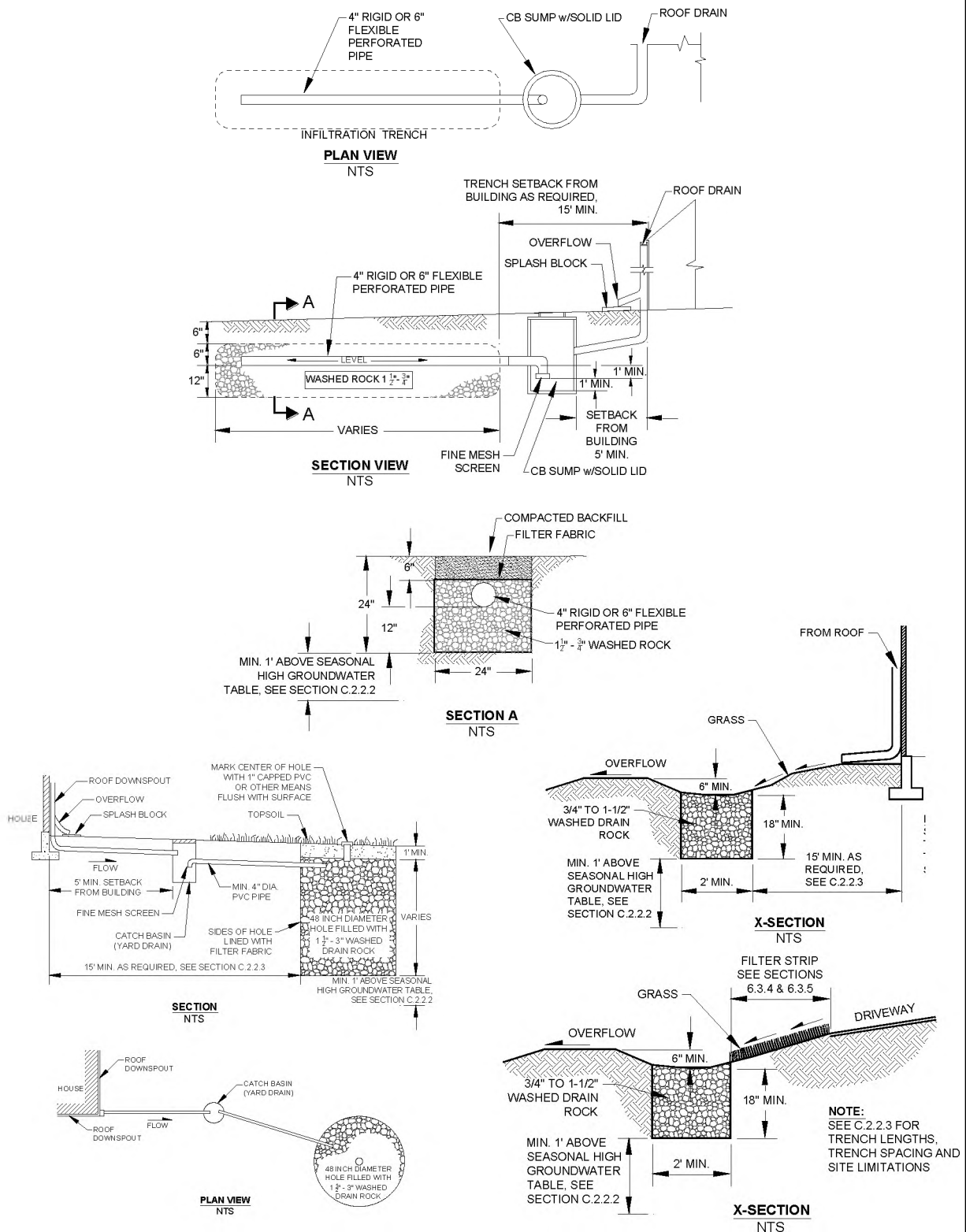
To be successful, the soil condition around the infiltration device must be able to soak water into the ground for a reasonable number of years.

- Infiltration devices must be inspected annually and after major storm events to identify and repair any physical defects.
- Maintenance and operation of the system should focus on ensuring the system's viability by preventing sediment-laden flows from entering the device. Excessive sedimentation will result in a plugged or non-functioning facility.
- If the infiltration device has a catch basin, sediment accumulation must be removed on a yearly basis or more frequently if necessary.
- Prolonged ponding around or atop a device may indicate a plugged facility. If the device becomes plugged, it must be replaced.
- Keeping the areas that drain to infiltration devices well swept and clean will enhance the longevity of these devices.
- For roofs, frequent cleaning of gutters will reduce sediment loads to these devices.

RECORDING REQUIREMENT

These limited infiltration flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

TYPICAL LIMITED INFILTRATION APPLICATIONS



MAINTENANCE INSTRUCTIONS FOR RAINWATER HARVESTING

Your property contains a stormwater management flow control BMP (best management practice) called "*rainwater harvesting*," which was installed to minimize the stormwater runoff impacts of impervious surface on your property.

Rainwater harvesting is a means for the collection and storage of roof runoff for domestic or irrigation use. **Rainwater harvesting systems** include a collection area, a filtering system, a storage device, and an outflow device.

MAINTENANCE RESTRICTIONS

The size, components, and configuration of the rainwater system as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

Rainwater harvesting systems include a *collection area*, a *filtering system*, a *storage device*, and an *outflow device*:

- The *collection area* (e.g., roof) should be routinely inspected for debris and other material that could impede the entrance and/or exit of surface flows.
- The *filtering system* should be periodically inspected for effectiveness and replaced or replenished as recommended by the manufacturer.
- The *storage device* must be drained completely during the dry season (May 1st - September 30th) in order to provide the needed capacity for an entire wet season.
- A maintenance log should be kept on site with the aforementioned information and dates of maintenance performance. King County inspection staff may request to view the maintenance log at any time.

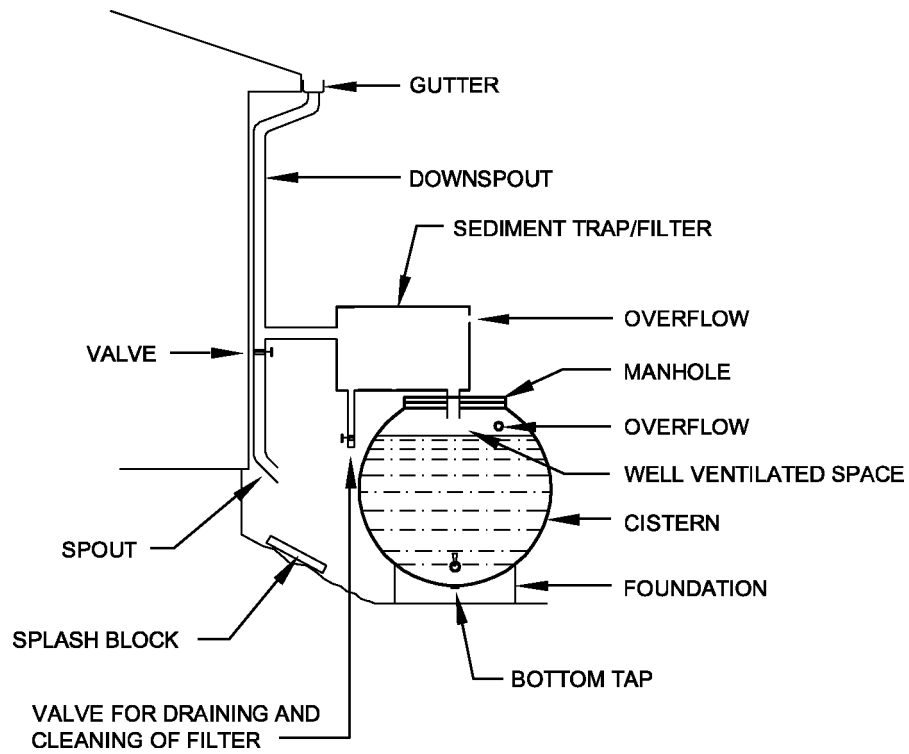
RECORDING REQUIREMENT

These rainwater harvesting flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

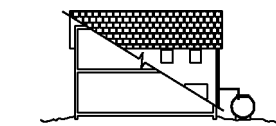
RAINWATER HARVESTING SYSTEM DESIGN REQUIREMENTS:

- To assure the system functions as designed and provides the required stormwater management, system-specific maintenance and operation instructions must be submitted with the small project drainage plan and approved by DLS-Permitting. Such instructions should be prepared by the system's manufacturer or installer.
- A minimum 5-foot setback shall be maintained between any part of the rainwater harvesting system and any property line.

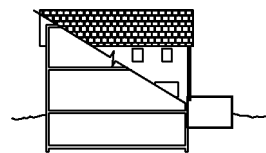
TYPICAL ABOVE GROUND RESERVOIR CONFIGURATION (STENSROD, 1978)



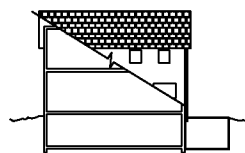
VARIOUS POSSIBLE RESERVOIR CONFIGURATIONS (TYPICAL) (STENSROD, 1978)



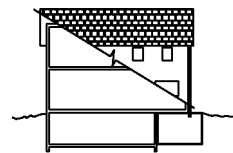
RESERVOIR ABOVE GROUND
(INSULATE IF NECESSARY)



PARTIALLY BURIED RESERVOIR



RESERVOIR BURIED OUTSIDE
BASEMENT



RESERVOIR IN BASEMENT

MAINTENANCE INSTRUCTIONS FOR VEGETATED ROOFS

Your property contains a stormwater management flow control BMP (best management practice) called a "*vegetated roof*," which was installed to minimize the stormwater runoff impacts of the impervious surfaces on your property.

Vegetated roofs (also called green roofs) consist of a pervious growing medium, plants, and a moisture barrier. The benefits of this device are a reduction in runoff peaks and volumes due to the storage capabilities of the soil and increased rate of evapotranspiration.

MAINTENANCE RESTRICTIONS

- The composition and area of vegetated roof as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.
- Vegetated roofs must not be subject to any use that would significantly compact the soil.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

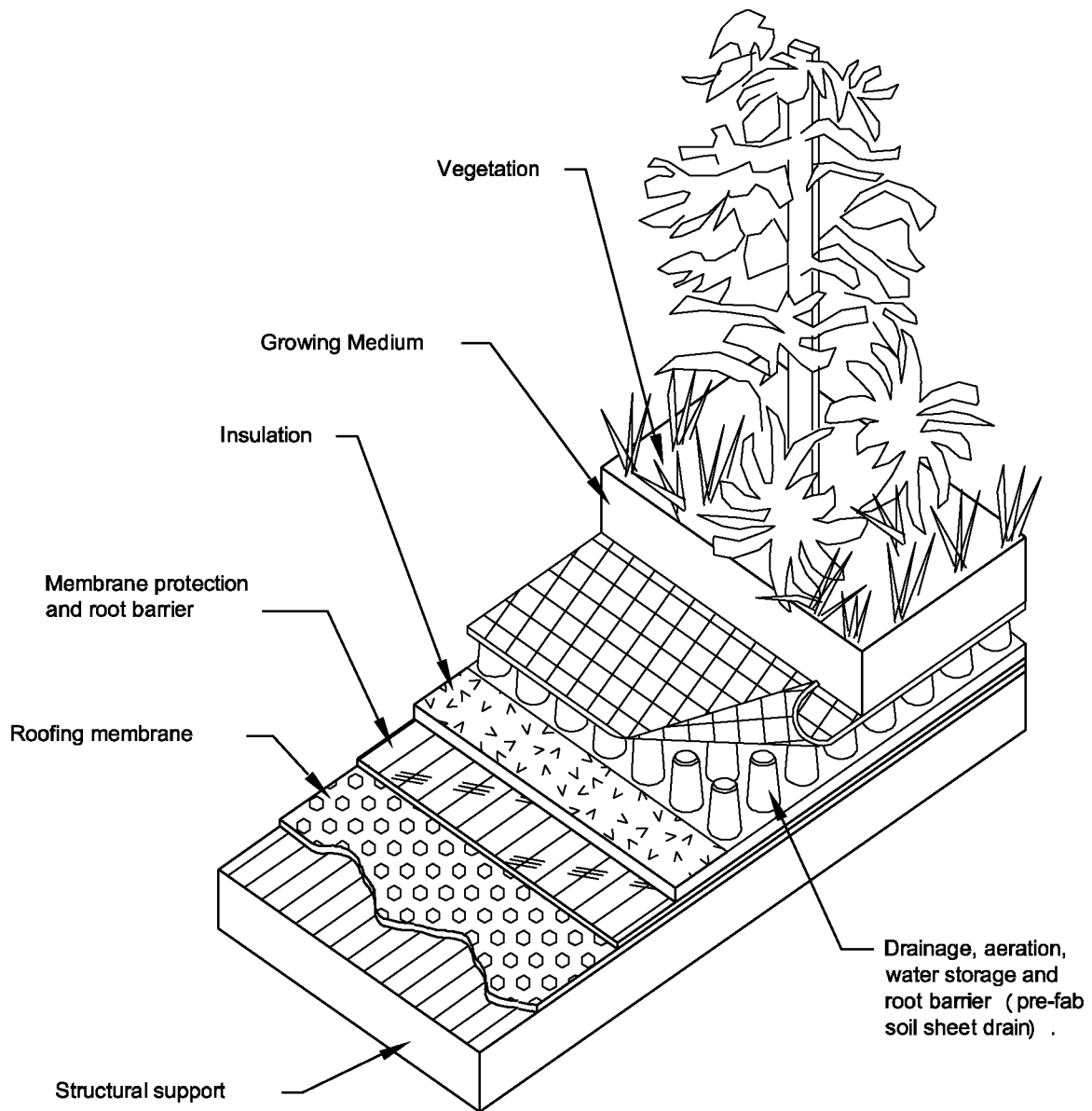
Vegetated roofs (also called green roofs) consist of a *pervious growing medium, plants, and a moisture barrier*:

- Vegetated roofs must be inspected annually for physical defects and to make sure the vegetation is in good condition.
- If erosion channels or bare spots are evident, they should be stabilized with additional soil similar to the original material.
- A supplemental watering program may be needed the first year to ensure the long-term survival of the roof's vegetation.
- Vegetation should be maintained as follows:
 - (1) vegetated roofs must not be subject to any use that would significantly compact the soil;
 - (2) replace all dead vegetation as soon as possible;
 - (3) remove fallen leaves and debris;
 - (4) remove all noxious vegetation when discovered;
 - (5) manually weed without herbicides or pesticides.

RECORDING REQUIREMENT

These vegetated roof flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

TYPICAL VEGETATED ROOF CROSS-SECTION



Note:
This example shows a two-part
prefabricated soil sheet drain
and protection board.

MAINTENANCE INSTRUCTIONS FOR REDUCED IMPERVIOUS SURFACE

BMP: RESTRICTED FOOTPRINT

Your property contains a stormwater management flow control BMP (best management practice) known as "*restricted footprint*," the practice of *restricting the amount of impervious surface that may be added* to a property so as to minimize the stormwater runoff impacts caused by impervious surface.

MAINTENANCE RESTRICTIONS

The **total impervious surface** on your property **may not exceed** _____ square feet without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.

RECORDING REQUIREMENT

These reduced impervious surface flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

MAINTENANCE INSTRUCTIONS FOR REDUCED IMPERVIOUS SURFACE

BMP: WHEEL STRIP DRIVEWAY

Your property contains a stormwater management flow control BMP (best management practice) called a "*wheel strip driveway*," which was installed to minimize or mitigate for the stormwater runoff impacts of some or all of the impervious surfaces on your property.

MAINTENANCE RESTRICTIONS

The placement and composition of the wheel strip driveway as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.

RECORDING REQUIREMENT

These reduced impervious surface flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

WHEEL STRIP DRIVEWAY DESIGN REQUIREMENTS for the typical 10-foot driveway width:

- The two **pavement strips** must be no more than 2.5-feet wide.
- At least 4 feet of the 10-foot driveway width must be **amended soil planted with grass**.
- The **amended soil** must consist of at least 4 inches of well-rotted compost tilled into the upper 8 inches of the soil between the impervious strips.

MAINTENANCE INSTRUCTIONS FOR REDUCED IMPERVIOUS SURFACE

BMP: MINIMUM DISTURBANCE FOUNDATION

Your property contains a stormwater management flow control BMP (best management practice) known as a "*minimum disturbance foundation*," which was installed to minimize or mitigate for the stormwater runoff impacts of some or all of the impervious surfaces on your property.

This means that all or a portion of the finished living space in your house is elevated over a pervious surface through the use of piers or piles. The pervious surface is intended to provide additional capacity to absorb and store the stormwater runoff from your roof and surrounding areas.

MAINTENANCE RESTRICTIONS

- The design of this system as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.
- In addition, the pervious surface beneath the elevated portion of your house must not be used in manner that compacts the soil or provides an opportunity for pollutants to enter the soil or storm runoff.

RECORDING REQUIREMENT

These reduced impervious surface flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

MINIMUM DISTURBANCE FOUNDATION DESIGN REQUIREMENTS:

- The **pervious surface beneath** the elevated portion of the structure must be either undisturbed native soil or amended soil. Any amended soil must consist of at least 4 inches of well-rotted compost tilled into the upper 8 inches of the soil.
- **Runoff** from the structure must be discharged via downspouts or sheet flow onto a vegetated surface or into a 4 to 6-inch gravel bed within close proximity of the elevated structure. Runoff discharging from downspouts onto a vegetated surface must be via splash blocks.

MAINTENANCE INSTRUCTIONS FOR REDUCED IMPERVIOUS SURFACE

BMP: OPEN GRID DECKING OVER PERVIOUS SURFACE

Your property contains a stormwater management flow control BMP (best management practice) called "*open grid decking over pervious surface*," which was installed to minimize or mitigate for the stormwater runoff impacts of some or all of the impervious surfaces on your property.

The decking has evenly spaced openings that allow rain water to reach the uncompacted soil below, where it has an opportunity to soak into the ground.

MAINTENANCE RESTRICTIONS

- The area and openings of the decking as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.
- In addition, the pervious surface beneath the decking must not be used in manner that compacts the soil.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Check monthly or as needed (e.g., weekly during the autumn season) to assure openings in the decking are not blocked and are draining freely. Sweep and/or vacuum as needed.
- Avoid the use of chemicals or other pollutants on the deck where they have an opportunity to pass through the decking and soak into the ground.

RECORDING REQUIREMENT

These reduced impervious surface flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

OPEN GRID DECKING DESIGN REQUIREMENTS:

- The pervious surface beneath the decking must be either undisturbed native soil or amended soil.
- Any amended soil must consist of at least 4 inches of well-rotted compost tilled into the upper 8 inches of the soil.

MAINTENANCE INSTRUCTIONS FOR NATIVE GROWTH RETENTION CREDIT

Your property contains a stormwater management flow control BMP (best management practice) known as "**native growth retention**," the practice of preserving a portion of a property in a native vegetated condition (e.g., forest) so as to minimize increases in stormwater runoff from clearing and to offset the stormwater runoff impacts caused by impervious surfaces on your property.

This native vegetated area on your property was *set aside by covenant* as "native growth retention area."

MAINTENANCE RESTRICTIONS

The "**native growth retention area**" is delineated on the flow control BMP site plan attached to the covenant. The trees, vegetation, ground cover, and soil conditions in this area may not be disturbed, except as allowed by the following provisions:

1. Trees may be harvested in accordance with a King County-approved forest management plan.
2. Individual trees that have a structural defect due to disease or other defects, and which threaten to damage a structure, road, parking area, utility, or place of employment or public assembly, or block emergency access, may be topped, pruned, or removed as needed to eliminate the threat.
3. Dead or fallen trees, tree limbs within ten feet of the ground, and branches overhanging a residence may be removed to reduce the danger of wildfire.
4. Noxious weeds (i.e., plant species listed on the State noxious weed list in Chapter 16-750 WAC) and invasive vegetation (i.e., plant species listed as obnoxious weeds on the noxious weed list adopted by the King County Department of Natural Resources and Parks) may be removed.
5. Passive recreation uses and related facilities, including pedestrian, equestrian community and bicycle trails, nature viewing areas, fishing and camping areas, and other similar uses that do not require permanent structures, are allowed if clearing and soil compaction associated with these uses and facilities does not exceed eight percent of the native growth retention area.

RECORDING REQUIREMENT

These native growth retention credit flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

MAINTENANCE INSTRUCTIONS FOR A PERFORATED PIPE CONNECTION

Your property contains a stormwater management flow control BMP (best management practice) called a "*perforated pipe connection*," which was installed to reduce the stormwater runoff impacts of some or all of the impervious surface on your property.

A perforated pipe connection is a length of drainage conveyance pipe with holes in the bottom, designed to "leak" runoff, conveyed by the pipe, into a gravel filled trench where it can be soaked into the surrounding soil. The connection is intended to provide opportunity for infiltration of any runoff that is being conveyed from an impervious surface (usually a roof) to a local drainage system such as a ditch or roadway pipe system.

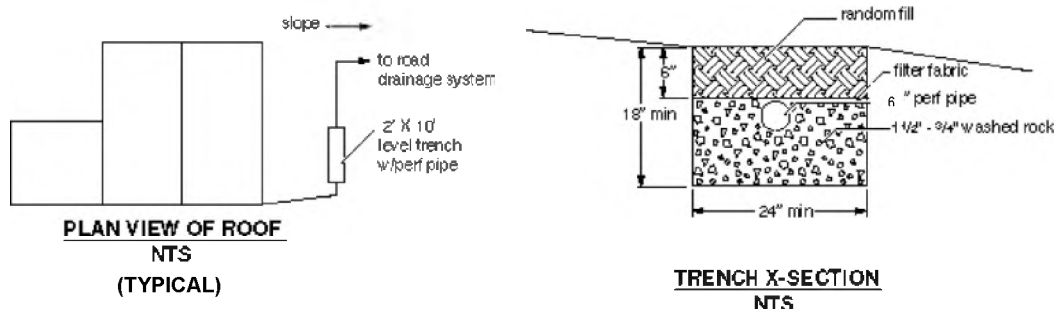
MAINTENANCE RESTRICTIONS

- The size and composition of the perforated pipe connection as depicted by the flow control BMP site plan and design details must be maintained and may not be changed without written approval either from the King County Water and Land Resources Division or through a future development permit from King County.
- The soil overtop of the perforated portion of the system must not be compacted or covered with impervious materials.

RECORDING REQUIREMENT

These **perforated pipe connection** flow control BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the King County *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the King County Department of Local Services, Permitting Division (DLS-Permitting) may require additional instructions based on site-specific conditions. See King County's Surface Water Design Manual website for additional information and updates.

TYPICAL PERFORATED PIPE CONNECTION FOR A SINGLE FAMILY RESIDENCE



KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-N
IMPERVIOUS SURFACE LIMIT
COVENANT

RECORDING REQUESTED BY AND
WHEN RECORDED MAIL TO:

DECLARATION OF COVENANT FOR IMPERVIOUS SURFACE LIMIT

Grantor: _____

Grantee: King County

Legal Description: _____

Additional Legal(s) on: _____

Assessor's Tax Parcel ID#: _____

IN CONSIDERATION of the approved King County _____ permit for application No. _____ relating to real property legally described above, the undersigned as Grantor(s), declares(declare) that the above described property is hereby established as having a limit to the amount of impervious surface allowed on the property for the purpose of limiting stormwater flows and is subject to the following restrictions.

The Grantor(s) hereby covenants(covenant) and agrees(agree) as follows: no more than _____ square feet of impervious surface coverage is allowed on the property. Impervious surface means a hard surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions before development; or that causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to

development. Common impervious surfaces include, but are not limited to, roof, walkways, patios, driveways, parking lots, or storage areas, areas that are paved, graveled or made of packed or oiled earthen materials, or other surfaces that similarly impede the natural infiltration of surface and storm water. King County or its municipal successors shall have a nonexclusive perpetual access easement on the Property in order to ingress and egress over the Property for the sole purposes of inspecting and monitoring the Property's impervious surface coverage.

This easement/restriction is binding upon the Grantor(s), its heirs, successors, and assigns unless or until a new drainage or site plan is reviewed and approved by the Department of Development and Environmental Services or its successor.

IN WITNESS WHEREOF, this Declaration of Covenant is executed this ____ day of _____, 20 ____.

GRANTOR, owner of the Property

GRANTOR, owner of the Property

STATE OF WASHINGTON)
COUNTY OF KING)ss.

On this day personally appeared before me:

_____, to me known to be the individual(s) described in and who executed the within and foregoing instrument and acknowledged that they signed the same as their free and voluntary act and deed, for the uses and purposes therein stated.

Given under my hand and official seal this ____ day of _____, 20 ____.

Printed name
Notary Public in and for the State of Washington,
residing at

My appointment expires _____

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-O
CLEARING LIMIT COVENANT

RECORDING REQUESTED BY AND
WHEN RECORDED MAIL TO:

DECLARATION OF COVENANT FOR CLEARING LIMIT

Grantor: _____

Grantee: King County

Legal Description: _____

Additional Legal(s) on: _____

Assessor's Tax Parcel ID#: _____

IN CONSIDERATION of the approved King County _____ permit
for application No. _____ relating to the real property ("Property") described
above, the Grantor(s), the owner(s) in fee of that Property, hereby declares (declare) that the Property is
established as having a native growth retention area for the purpose of dispersing and treating stormwater
flows and is subject to restrictions applying to vegetation removal in all designated areas shown in
Exhibit A attached hereto, and hereby covenants (covenant) and agrees (agree) as follows:

1. Any alterations to critical areas, their buffers, and native growth retention areas shall be
pursuant to applicable King County Code.

2. The property within the native growth protection area (shown in Attachment A) shall be maintained in a forested condition, with the exception of open water and existing non-forested native wetland plant communities. The following activities are allowed and must be done in a manner that maintains forested hydrologic conditions and soil stability:

a. Removal of noxious weeds and non-native vegetation using hand equipment, provided that those areas are replanted with appropriate native vegetation.

b. Removal of dangerous and diseased trees.

c. Passive recreation and related activities including trails, nature viewing, fishing, camping areas, and other similar activities that do not require permanent structures, provided that cleared areas and areas of compacted soil associated with these areas and facilities do not exceed eight percent of the native growth retention area.

d. The native growth retention area may contain utilities and utility easements including flow control BMPs, but not including septic systems.

e. Limited trimming and pruning of vegetation for the creation and maintenance of views per applicable King County Code.

f. Timber harvest in accordance with a King County-approved forest management plan and appropriate permits.

3. King County shall have a nonexclusive perpetual access easement on the Property in order to ingress and egress over the Property for the sole purposes of inspecting and monitoring the Property's native growth retention area.

4. This easement/restriction is binding upon the Grantor(s), his/her (their) heirs, successors and assigns unless or until a new drainage or site plan is reviewed and approved by the Department of Development and Environmental Services or its successor.

IN WITNESS WHEREOF, this Declaration of Covenant is executed this ____ day of _____, 20 ____.

GRANTOR, owner of the Property

GRANTOR, owner of the Property

STATE OF WASHINGTON)
COUNTY OF KING)ss.

On this day personally appeared before me:

_____, to me known to be the individual(s) described in and who executed the within and foregoing instrument and acknowledged that they signed the same as their free and voluntary act and deed, for the uses and purposes therein stated.

Given under my hand and official seal this ____ day of _____, 20 ____.

Printed name

Notary Public in and for the State of Washington,
residing at

My appointment expires _____

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-P
RIVER PROTECTION EASEMENT

AFTER RECORDING RETURN TO:

King County Property Services Division
500A King County Administration Building
500 Fourth Avenue
Seattle, WA 98104

Document Title: River Protection Easement

Reference Number of Related Document:

Grantor(s):

Grantee(s): King County

Legal Description:

Assessor's Tax Parcel Number:

RIVER PROTECTION EASEMENT

For valuable consideration, receipt of which is hereby acknowledged, the GRANTOR(S),

owner(s) in fee of that certain parcel of land (the "Property"), legally described as follows:

hereby grant(s) to KING COUNTY, a political subdivision of the State of Washington , its successors and assigns, agents and licensees (GRANTEE), a perpetual easement for the purposes of accessing and constructing, inspecting, monitoring, reconstructing, maintaining, repairing, modifying, and removing river bank protection and/or other flood related works, including installing, inspecting, maintaining and removing all vegetation and any other appurtenances

thereto across, in, under, on, over and upon the following portions of the above described Property:

All portions of the above described parcel that are riverward of a line that is parallel to and thirty (30) feet landward of the stable top of the river bank on the _____ River ("Easement Area"), as constructed or reconstructed, together with reasonable ingress and egress upon the Property to access the Easement Area.

Grantee shall have the right at such time as may be necessary and at the Grantee's sole discretion, to enter upon the Property and to have unimpeded access to, in and through the Easement Area for the purposes of exercising the Grantee's rights as described herein.

Grantor agrees not to plant non-native vegetation within the Easement Area and not to remove or otherwise alter any improvements installed by Grantee, including any native vegetation that may be planted and any flood protection works that may be constructed, within the Easement Area, without the prior approval of Grantee. Grantor further agrees not to use herbicides within the Easement Area without the prior approval of Grantee. Nothing contained herein shall be construed as granting any license, permit or right, otherwise required by law, to Grantor with respect to the Property and the Easement Area.

For the purposes of this river protection easement, the term "native vegetation" shall mean vegetation comprised of plant species, other than noxious weeds (as identified on the State of Washington noxious weed list found at Washington Administrative Code Chapter 16-750, as amended from time to time), which are indigenous to the coastal region of the Pacific Northwest and which reasonably could have been expected to naturally occur at the site.

Neither Grantor nor Grantee is hereby obligated to future maintenance, repair or other action related to the above-described exercise of easement rights. This river protection easement and/or any flood related works constructed or to be constructed within the Easement Area shall not be construed as granting any rights to any third person or entity, or as a guarantee of any protection from flooding or flood damage, and nothing contained herein shall be construed as waiving any immunity to liability granted to Grantee by any state statute, including Chapter 86.12 of the Revised Code of Washington, or as otherwise granted or provided for by law.

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 8-Q
LEACHABLE METALS COVENANT

RECORDING REQUESTED BY AND
WHEN RECORDED MAIL TO:

DECLARATION OF COVENANT PROHIBITING USE OF LEACHABLE METALS

Grantor: _____

Grantee: King County

Legal Description: _____

Additional Legal(s) on: _____

Assessor's Tax Parcel ID#: _____

IN CONSIDERATION of the approved King County _____ permit for application No. _____ relating to real property legally described above, the undersigned as Grantor(s), declares(declare) that the above described property is hereby established as having a prohibition on the use of leachable metals on those portions of the property exposed to the weather for the purpose of limiting metals in stormwater flows and is subject to the following restrictions.

The Grantor(s) hereby covenants(covenant) and agrees(agree) as follows: no leachable metal surfaces exposed to the weather will be allowed on the property. Leachable metal surfaces means a surface area that consists of or is coated with a non-ferrous metal that is soluble in water. Common leachable metal surfaces include, but are not limited to, galvanized steel roofing, gutters, flashing, downspouts, guardrails, light posts, and copper roofing. King County or its municipal successors shall

have a nonexclusive perpetual access easement on the Property in order to ingress and egress over the Property for the sole purposes of inspecting and monitoring that no leachable metal is present on the Property.

This easement/restriction is binding upon the Grantor(s), its heirs, successors, and assigns unless or until a new drainage or site plan is reviewed and approved by the Department of Development and Environmental Services or its successor.

IN WITNESS WHEREOF, this Declaration of Covenant is executed this ____ day of _____, 20 ____.

GRANTOR, owner of the Property

GRANTOR, owner of the Property

STATE OF WASHINGTON)
COUNTY OF KING)ss.

On this day personally appeared before me:

_____, to me known to be the individual(s) described in and who executed the within and foregoing instrument and acknowledged that they signed the same as their free and voluntary act and deed, for the uses and purposes therein stated.

Given under my hand and official seal this ____ day of _____, 20 ____.

Printed name
Notary Public in and for the State of Washington,
residing at

My appointment expires _____

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 9
INTERIM CHANGES TO
REQUIREMENTS

- 9-A Blanket Adjustments
- 9-B Administrative Changes

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 9-A
BLANKET ADJUSTMENTS

None at this time

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 9-B
ADMINISTRATIVE CHANGES

None at this time

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 10
**KING COUNTY-IDENTIFIED WATER
QUALITY PROBLEMS**

None at this time

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 11
MATERIALS

11-A (VACANT)

11-B (VACANT)

11-C Bioretention Soil Media Standard Specifications

11-D (VACANT)

11-E Roofing Erodible or Leachable Materials

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 11-C
BIORETENTION SOIL MEDIA
STANDARD SPECIFICATIONS

REFERENCE 11-C

BIORETENTION SOIL MEDIA STANDARD SPECIFICATIONS

11-C.1 COMPOST

Compost products shall be the result of the biological degradation and transformation of uncontaminated biological organic materials under controlled conditions designed to promote aerobic decomposition. Compost shall be stable with regard to oxygen consumption, carbon dioxide generation, and seed germination and seedling vigor. Compost shall be mature with regard to its suitability for use in stormwater facilities and BMPs, post-construction soil amendment, general landscaping, or an erosion control BMP as defined below.

Compost shall be tested at a minimum in accordance with the U.S. Composting Council “Testing Methods for the Examination of Compost and Composting” (TMECC), as established in the Composting Council’s “Seal of Testing Assurance” (STA) program. Most Washington compost facilities now use these tests. All tests must be done on compost screened to specification for its intended use.

11-C.1.A SPECIFICATION 1 COMPOST

1. Compost must be produced at a facility that is permitted by the jurisdictional health authority. Permitted compost facilities in Washington are included on a list available at <https://ecology.wa.gov/Asset-Collections/Doc-Assets/Solid-waste/Solid-waste-recycling-data/Composting-facilities-and-materials>.
2. Compost must meet the definition of "composted material" in WAC 173-350-100, and must comply with testing parameters and other standards including not exceeding contaminant limits identified in Table 220-B. Testing Parameters, in WAC 173-350-220; and "Physical contaminants" (as defined in WAC 173-350-100) content less than 1% by weight (TMECC 03.08-A) total, not to exceed 0.25 percent film plastic by dry weight.
3. The compost product must originate a minimum of 65 percent by volume from recycled plant waste comprised of “yard debris,” “crop residues,” and “bulking agents” as those terms are defined in WAC 173-350-100. A maximum of 35 percent by volume of “post-consumer food waste” as defined in WAC 173-350-100 may be substituted for recycled plant waste. Biosolids, manure, and/or bedding straw or wood chips or shavings containing animal excreta are not allowed.
4. Wood waste from chemically treated lumber and manufactured wood products containing adhesives or any other chemical is not allowed; painted and stained wood are not allowed; and only sawdust from virgin lumber allowed. No other toxic or otherwise harmful materials are allowed.
5. For *high-density residential subdivision development, multi-family, commercial, and industrial projects, and road projects considered high ADT projects*,* the Manufacturer or Vendor shall provide to the end buyer a list of feedstock sources by percentage by volume in the final compost product.
6. Compost shall have a moisture content that has no visible free water or dust produced when handling the material.
7. Compost shall have an organic matter content of 40 percent to 65 percent by dry weight as determined by loss of ignition test method ASTM D 2974, or by U.S. Composting Council TMECC 05.07A "Loss-On-Ignition Organic Matter Method (LOI)".

* Land uses as described in Bullets 1, 2, and 3, SWDM Section 1.2.8.1, Subsection A “Basic WQ Treatment Areas, Required Treatment Menu”

8. Compost shall have a carbon to nitrogen ratio below 25:1, although the carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region. The carbon to nitrogen ratio shall be calculated on a dry weight basis using TMECC 5.02A ("Carbon to Nitrogen Ratio"), which uses TMECC 04.01A, "Organic Carbon" divided by the dry weight of "Total N" (TMECC 04.02D).
9. Compost pH shall be between 6.0 and 8.5 when tested in accordance with U.S. Composting Council TMECC 04.11-A, "1:5 Slurry pH"
10. Soluble salt content shall be less than 4.0 dS/m (mmhos/cm) when tested in accordance with U.S. Composting Council TMECC 04.10 "Electrical Conductivity, 1:5 Slurry Method, Mass Basis".
11. Compost maturity indicators from a cucumber bioassay (TMECC 05.05-A "Germination Seedling Emergence and Relative Growth") must be greater than 80% for both emergence and vigor).
12. Stability shall be 7-mg CO₂ – C/g OM/day or below in as determined by U.S. Composting Council TMECC 05.08-B "Carbon Dioxide Evolution Rate", to establish low oxygen use and low CO₂ generation rates.

Compost shall be screened to the Fine Compost size gradation specification in Section 11-C.1.C of this Reference.

11-C.1.B SPECIFICATION 2 COMPOST

1. Specification 2 Compost manufacturing, feedstocks, and testing are all identical to Specification 1 Compost except that:
 - a. A maximum of 35 percent by volume of biosolids or manure may be substituted for recycled plant waste.
 - b. Compost may be fine or coarse gradation depending on use and need to meet other screened material quality criteria.
 - c. Carbon to Nitrogen ratio may be up to 40:1 for coarse compost to be used as a surface mulch (not in a soil mix).

11-C.1.C COMPOST SCREENING SIZE GRADATIONS

Where compost gradation is specified, it must meet the following size gradations when tested in accordance with the U.S. Composting Council "Test Methods for the Examination of Compost and Composting" (TMECC) Test Method 02.02-B.

Fine Compost shall meet the following gradation by dry weight:

Minimum percent passing 2" sieve	100%
Minimum percent passing 1" sieve	99%
Minimum percent passing 5/8" sieve	90%
Minimum percent passing 1/4" sieve	75%

Coarse Compost shall meet the following gradation by dry weight:

Minimum Percent passing 3" sieve	100%
Minimum Percent passing 1" sieve	90%
Minimum Percent passing 3/4" sieve	70%
Minimum Percent passing 1/4" sieve	40%

11-C.1.D COMPOST ACCEPTANCE REQUIREMENTS

The Contractor shall submit the following information to the King County Department of Permitting and Environmental Review (DPER) Engineer for approval:

1. If the manufacturer is not exempt under Table 220-A, “Terms and Conditions for Solid Waste Permit Exemptions”, a copy of the Solid Waste Handling Permit issued to the compost manufacturer by the Jurisdictional Health Department in accordance with WAC 173-350 (Minimum Functional Standards for Solid Waste Handling) or for biosolids composts a copy of the Coverage Under the General Permit for Biosolids Management issued to the manufacturer by the Department of Ecology in accordance with WAC 173-308 (Biosolids Management).
2. The Applicant shall provide written verification and lab analyses that the material complies with the processes, testing, and standards specified in WAC 173-350 and these Specifications. An independent Seal of Testing Assurance (STA) Program certified laboratory[†] or a laboratory accredited by WA Ecology[‡] for the specified methods shall perform the analyses. Lab analysis shall be for the compost delivered on site for project use.
3. A copy of the STA laboratory's Seal of Testing Assurance STA certification as issued by the U.S. Composting Council, or a copy of the Ecology-certified laboratory's accreditation for the specified methods.

11-C.2 BIORETENTION SOIL MIX SPECIFICATIONS

Follow the specification below for the approved default bioretention soil mix. Alterations to this specification require an approved adjustment.

11-C.2.A DEFAULT BIORETENTION SOIL MIX

Bioretention Soil Mix (BSM) shall be a well-blended homogeneous mixture of Bioretention Mineral Aggregate and Bioretention Compost measured on a volume basis composed of:

- 35 to 40 percent by volume Specification 1 Compost per Section 11-C.1.A above and Section 11-C.2.B below.
- 60 to 65 percent by volume Bioretention Mineral Aggregate per Section 11-C.2.C below.

Projects which prefer to create a custom Bioretention Soil Mix rather than using the default requirement above must demonstrate compliance with criteria as described in Ecology's *Stormwater Management Manual for Western Washington (2014) Volume V – Runoff Treatment BMPs*, except that any more stringent compost criteria required by this Reference 11-C are applicable.

11-C.2.B BIORETENTION COMPOST

Bioretention Compost shall be Specification 1, Fine Compost per Sections 11-C.1.A and 11-C.1.C of this Reference. Fine Specification 1 Compost shall be used for Bioretention Soil Mix and for any compost used to amend bioretention cell soil.

11-C.2.C BIORETENTION SOIL MIX AGGREGATE

Aggregate Gradation

The following table provides a gradation guideline for the aggregate component of a Bioretention Soil Mix specification in western Washington. This sand gradation is often supplied as a well-graded utility or screened. With compost, this blend provides enough fines for adequate water retention, hydraulic

[†] A list of STA certified laboratories can be found at <http://compostingcouncil.org/labs/>.

[‡] A list of WA Ecology accredited laboratories can be found at <http://www.ecy.wa.gov/programs/eap/labs/>. Only laboratories certified for the specified methods may be used for compost testing.

conductivity within recommended range (see below), pollutant removal capability, and plant growth characteristics for meeting design guidelines and objectives.

TABLE 11-C.2.A BIORETENTION SOIL MIX MINERAL AGGREGATE GRADATION	
Sieve Size	Percent Passing
3/8"	100
#4	95-100
#10	75-90
#40	25-40
#100	4-10
#200	2-4

Where existing soils meet the above aggregate gradation, those soils may be amended rather than importing mineral aggregate.

11-C.3 BIORETENTION MULCH

Mulch may only be composed of either chipped wood as defined in Section 11-C.3.A, or compost as defined in Section 11-C.3.B. Mulch may not be made of synthetic materials including but not limited to recycled tire material, virgin rubber material, plastics; or pre-or post-consumer cardboard.

11-C.3.A ARBORIST'S WOOD CHIP MULCH

Arborist Wood Chip Mulch shall be coarse ground wood chips (approximately 1/2" to 6" along the longest dimension) derived from the mechanical grinding or shredding of the above-ground portions of trees. It may contain wood, wood fiber, bark, branches, and leaves, but may not contain visible amounts of soil. It shall be free of weeds and weed seeds including but not limited to plants on the King County Noxious Weed list available at: www.kingcounty.gov/weeds, and shall be free of invasive plant portions capable of re-sprouting, including but not limited to horsetail, ivy, clematis, knotweed, etc. It may not contain more than 0.5% by dry weight of manufactured inert material (plastic, concrete, ceramics, metal, etc.).

Arborist Wood Chip Mulch, when tested, shall meet the following loose volume gradation:

TABLE 11-C.3.A ARBORIST WOOD MULCH GRADATION	
Sieve Size	Percent Passing
2"	95 – 100
1"	70 – 100
5/8	0 – 50
No. 4	0 – 30

Prior to delivery, the Applicant shall provide the following:

1. The source of the product and species of trees included in it;
2. A sieve analysis verifying the product meets the above size gradation requirement;
3. A representative sample of the product for County approval.

11-C.3.B COMPOST MULCH SPECIAL REQUIREMENTS

- Compost Mulch for Bioretention must meet the **Specification 1** compost requirements of Section 11-C.1.A, except that the gradation must be **Coarse Compost** per Section 11-C.1.C
- Compost Mulch for other facilities and BMPs must meet either **Specification 1 or Specification 2** compost of Section 11-C.1.A or 11-C.1.B respectively, except that the gradation must be **Coarse Compost** per Section 11-C.1.C.

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KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 11-E
ROOFING ERODIBLE OR LEACHABLE
MATERIALS

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REFERENCE 11-E

ROOFING ERODIBLE OR LEACHABLE MATERIALS

Metal roofing coating: Inert, non-leachable material

Metal roofs are considered to be pollution generating impervious surface unless they are coated with PVDF (Polyvinylidene Fluoride) with a manufacturer's 25-year or better guarantee of no metals leaching, and are not subject to venting significant amounts of dusts, mists, or fumes from manufacturing, commercial, or other indoor activities.

Non-metal roofing types that may pose risk but are not currently regulated

The following roof types are currently not regulated as pollution generating surfaces, but there is some evidence that they may pose risks to water quality. This information is provided to assist the public in making more informed choices.

These roof types include any roofing manufactured or treated with biocides for moss, algae, rot, or plant control; i.e. those containing any heavy metal such as copper, lead, zinc, silver, or arsenic, or organic biocides such as (R,S)-mecoprop bi-ester¹ and terbutryn, carbendazim, and Irgarol 1051².

Other roof types that may pose risk include synthetic roofing materials that use zinc or any other leachable heavy metal as a manufacturing catalyst or for any other purpose, any roofing material containing any heavy metal as a UV stabilizer or for pigmentation³. Phthalates have also been noted as leaching from some synthetic roofing.

❑ SPECIFIC EXAMPLES OF NON-METAL AND COATED METAL ROOFS FOR WHICH THERE IS DOCUMENTED EVIDENCE OF SOME RUNOFF RISK

Roofs with potential risk based on regional monitoring of regionally supplied materials^{4,5}

- Asphalt shingles with algae resistance (AR)
- EPDM (ethylene propylene diene monomer)
- Manufacturer-painted galvanized steel, painted with silicone-modified polyester paint^{6, 4}
- PVC (polyvinyl chloride)
- Treated wood shakes

¹ Bucheli, Thomas D., Stephan R. Müller, Andreas Voegelin, and René P. Schwarzenbach. 1998. Bituminous Roof Sealing Membranes as Major Sources of the Herbicide (R,S)-Mecoprop in Roof Runoff Waters: Potential Contamination of Groundwater and Surface Waters. *Environmental Science & Technology* 32 (22):3465-3471.

² Background literature review in support of the regional study by Ecology. Winters, Nancy. 2013. Quality Assurance Project Plan. Roofing Materials Assessment: Investigation of Toxic Chemicals in Roof Runoff. Publication No. 13-03-105. Lacey, WA: Washington State Department of Ecology.

³ Polybrominated diphenyl ethers (PBDE) or other fire retardants may be an issue in Central and Eastern Washington, but according to manufacturers on Ecology's Roofing Task Force, these are not applied in Western Washington.

⁴ Materials provided by Western Washington manufacturers and/or vendors. First year of study. Winters, Nancy, and Kyle Graunke. 2014. Roofing Materials Assessment - Investigation of Toxic Chemicals in Roof Runoff. Lacey, WA. <https://fortress.wa.gov/ecy/publications/SummaryPages/1403003.html>

⁵ Materials provided by Western Washington manufacturers and/or vendors. Winters, Nancy, Melissa McCall, and Allison Kingfisher. 2014. Roofing Materials Assessment - Investigation of Toxic Chemicals in Roof Runoff from Constructed Panels in 2013 and 2014. Publication No. 14-03-033. Lacey, WA.

Roofs with potential risk based on other Studies⁶

- Asphalt shingles
- Asphalt fiberglass shingles
- Asphalt (residential)
- Asphalt impregnated with copper
- Asphalt roofs with moss-control zinc strips
- Bituminous roof sealing membrane for green roof, treated to inhibit root penetration
- Built-up commercial
- Built-up with coal tar
- Cedar shakes
- Ceramic tile
- Clay tile
- Concrete tile
- Ethylene propylene diene monomer (EPDM or rubber roofing)
- Galfan (aluminum-coated)
- Gravel
- Impregnated wood
- Ondura
- Painted steel
- Pressure treated / water sealed wood
- Polyester
- Polyvinyl Chloride (PVC)
- Synthetic roofing materials, e.g. thermoplastic olefin (TPO)
- Rubber
- Treated roofing materials (non-specific as cited)
- Vegetated roof
- Wood shingle

⁶ Background literature review in support of the regional study by Ecology. Winters, Nancy. 2013. Quality Assurance Project Plan. Roofing Materials Assessment: Investigation of Toxic Chemicals in Roof Runoff. Publication No. 13-03-105. Lacey, WA: Washington State Department of Ecology.

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KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 14
SUPPLEMENTAL APPROVED
FACILITIES

14-A King County Approved Proprietary Facilities

14-B King County Approved Public Domain Facilities

KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 14-A
KING COUNTY APPROVED
PROPRIETARY FACILITIES

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REFERENCE 14-A

KING COUNTY APPROVED PROPRIETARY FACILITIES

1. STORMFILTER

The Stormwater Management StormFilter[®] (StormFilter) is a flow-through stormwater filtration system comprised of a vault that houses media-filled cartridges. As stormwater fills the treatment chamber, stormwater filters through the media to the center of the cartridge, and treated stormwater is collected and discharged through underdrain collection pipes. Figure 14-A.1.A shows a schematic representation of a StormFilter.

Applications and Limitations

A StormFilter with ZPG[™] (zeolite/perlite/granulated activated carbon) media may be used as a single facility (with pretreatment) to meet the Basic treatment requirement. In addition, the StormFilter with ZPG may be used as the first (Basic) facility in a treatment train to meet Enhanced Basic, Sensitive Lake Protection, or as the first or second facility in a treatment train to meet Sphagnum Bog Protection. Use of the StormFilter with ZPG as the first facility in a treatment train will require pretreatment.

A StormFilter with CSF[™] (leaf compost) media is not approved by Ecology and therefore may not be used as a second water quality facility in an Enhanced Basic treatment train. However, A StormFilter with CSF[™] media may be used in a treatment train for sphagnum bog protection, or to mitigate a downstream high pH problem¹.

The StormFilter is capable of being filled with several types of filter media. Until additional performance data is collected for additional types, **only the ZPG media is acceptable to meet Basic water quality requirements, and CSF is only acceptable as part of a treatment train for Sphagnum Bog Protection**. Other types of media may be allowed with an Experimental Design Adjustment after the media has been approved through the Washington State Department of Ecology's TAPE² program (see SWDM Section 1.4.2 and Reference 8-F). An adjustment without presettling may be considered on an experimental basis for drainage basins less than ½ acre of impervious area. The StormFilter with ZPG media does not meet the Lake Protection Standard as a stand-alone facility.

Consult the water quality menus in SWDM Section 6.1 for specific information on how a StormFilter may be used to meet Core Requirement # 8.

A. METHODS OF ANALYSIS

StormFilter sizing is based on the water quality design flow and a mass loading method. Since the process and the compost are patented, CONTECH Engineered Solutions (CES; or their successor) personnel will configure a StormFilter based on the design flow provided and specific *site* characteristics. The WQ design flow should be based on the modeled flows, described in Chapter 6 and determined using the guidance per the approved model's user reference, rather than on other flow-estimation methods. An accurate description of land use and potential sediment and pollutant loading sources shall also be provided to CES personnel, who will consider these factors in sizing. The specific sizing methodologies are described below.

¹ See SWDM Sections 1.2.2.1: Downstream Analysis, High pH Problem (Type 7), and 1.2.2.2: Drainage Problem Impact Mitigation

² Technology Assessment Protocol - Ecology

□ STORMFILTER WITH ZPG MEDIA FOR BASIC WATER QUALITY TREATMENT

1. The maximum flow rate (gpm/cartridge) is based on the effective cartridge height. The **maximum flow rate per cartridge** shall be per Table14-A.1.A (below). The maximum specific flow rate is 1 gpm/ft² of media surface area.
2. The **water quality design flow** shall be as follows, whichever is applicable:
 - **Preceding detention (or no detention):** the *on-line* or *off-line* (as applicable) WQ flow rate, as determined using the Approved Model with 15-minute time steps calibrated to *site* conditions.³ *The flow rate reported by the model is to be used directly for this application and is **not** to be modified per SWDM Section 6.2.1*
 - **Downstream of flow control:** The full 2-year release rate from the detention facility.
3. The StormFilter shall be **sized using both the flow-based and mass-based methods** as described in the *Product Design Manual Version 4.1 (April 2006)*, or the most current version, and the designer shall select the result yielding the larger number of cartridges.
4. **Presettling** shall be provided per SWDM Section 6.5.1, “General Requirements for Filtration Facilities”.
5. StormFilter systems shall be installed in such a manner that the **flows exceeding the design flow rates** are bypassed or will not suspend captured sediments.
6. **ZPG media shall conform to the following specifications.** Verification that these specifications are met shall be required.
 - a) Each cartridge contains a total of approximately 2.6 cubic feet of media. The **ZPG cartridge** consists of an outer layer of perlite that is approximately 1.3 cubic feet in volume and an inner layer, consisting of a mixture of 90% zeolite and 10% granular activated carbon, which is approximately 1.3 cubic feet in volume.
 - b) **Zeolite Media:** Zeolite media shall be made of naturally occurring clinoptilolite. The zeolite media shall have a bulk density ranging from 44 to 50 lbs per cubic foot and particle sizes ranging from 0.13" (#6 mesh) to 0.19" (#4 mesh). Additionally, the cation exchange capacity (CEC) of zeolite shall range from approximately 1.0 to 2.2 meq/g.
 - c) **Perlite Media:** Perlite media shall be made of natural siliceous volcanic rock free of any debris or foreign matter, The expanded perlite shall have a bulk density ranging from 6.5 to 8.5 lbs per cubic foot and particle size ranging from 0.09" (#8 mesh) to 0.38" (3/8" mesh).
 - d) **Granular Activated Carbon:** Granular activated carbon (GAC) shall be made of lignite coal that has been steam-activated. The GAC media shall have a bulk density ranging from 28 to 31 lbs per cubic foot and particle sizes ranging from a 0.09" (#8 mesh) to 0.19" (#4 mesh).

TABLE14-A.1.A MAXIMUM STORMFILTER DESIGN FLOW RATES PER CARTRIDGE FOR BASIC TREATMENT WITH ZPG MEDIA

Effective Cartridge Height (inches)	12	18	27
Cartridge Flow Rate (gpm/cartridge)	5	7.5	11.25

³ The StormFilter with ZPG has general use level designation (GULD) approval for Basic treatment (80% TSS removal) through WA Ecology's TAPE (Technology Assessment Protocol – Ecology), based on water quality design flow specified in the GULD approval document.
https://fortress.wa.gov/ecy/ezshare/wq/tape/use_designations/STORMFILTERzpg1GPMCONTECHguld.pdf

❑ STORMFILTER WITH CSF LEAF MEDIA FOR SPHAGNUM BOG PROTECTION TREATMENT.

1. The **water quality design flow** shall be as follows, whichever is applicable:
 - **Preceding detention (or no detention):** the *on-line* or *off-line* (as applicable) WQ flow rate, as determined using the Approved Model with 15-minute time steps calibrated to *site* conditions. *The flow rate reported by the model is to be used directly for this application and is **not** to be modified per SWDM Section 6.2.1*
 - **Downstream of flow control:** The full 2-year release rate from the detention facility.
2. The **maximum specific flow rate** shall be 2 gpm/ft² of media surface area.
3. The StormFilter shall be **sized using both the flow-based and mass-based methods** as described in the *Product Design Manual Version 4.1 (April 2006)*, or the most current version, and the designer shall select the result yielding the larger number of cartridges.

**TABLE 14-A.1.B MAXIMUM STORMFILTER DESIGN FLOW RATES
PER CARTRIDGE FOR SPHAGNUM BOG PROTECTION WITH CSF
MEDIA**

Effective Cartridge Height (inches)	12	18	27
Cartridge Flow Rate (gpm/cartridge)	10	15	22.5

B. DESIGN CRITERIA

Figure 14-A.1.A (p. Ref 14A-5) illustrates the general configuration of a typical StormFilter unit using standard precast concrete vaults.

General

1. Vaults used for a StormFilter shall conform to the "**Materials**" and "**Structural Stability**" requirements specified for detention vaults (see SWDM Section 5.1.3).
2. Several vault sizes are available for the StormFilter. The details of cartridge configuration and maximum number of cartridges allowed in each size vault are available in Reference Section 7C, StormFilter Access and Cartridge Configuration.

Presettling

Presettling is required as described in SWDM Section 6.5.1, "General Requirements for Filtration Facilities".

Access Requirements

1. **Access must be provided** by either removable panels or other King County approved accesses to allow for removal and replacement of the filter cartridges. Approved access details are available in Reference Section 7C, StormFilter Access and Cartridge Configuration. Removable panels, if used, shall be at grade, have stainless steel lifting eyes, and weight no more than 5 tons per panel.
2. Access to the **inflow and outlet cells** must also be provided.
3. **Ladder access** is required. A minimum 2-foot diameter lateral clear access shall be provided between the entry ladder and any other obstacle, e.g. the nearest cartridge extremity.
4. **Locking lids** shall be provided as specified for detention (see SWDM Section 5.1.3).

5. If removable panels or the Reference Section 7C access configurations are not used, corner **ventilation pipes** shall be provided, and the **minimum internal height and width and maximum depth** shall be met (see SWDM Section 5.1.3).

Access Roads, Right of Way, and Setbacks

Same as for detention vaults (see SWDM Section 5.1.3).

Construction Considerations

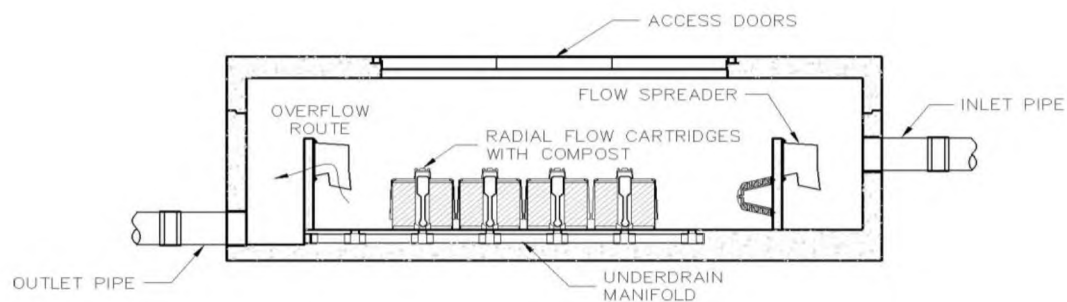
Installation of a StormFilter cartridge filter facility shall follow the manufacturer's recommended procedures.

Maintenance Requirements

Maintenance needs vary from *site* to *site* based on the type of land use activity, implementation of source controls, and weather conditions. The StormFilter shall be inspected quarterly or at a frequency recommended by the supplier. Inspection and maintenance shall include the following:

1. The operation and maintenance instructions from the manufacturer shall be kept along with an inspection and maintenance log. The **maintenance log** shall be available for review by County inspectors.
2. **Routine maintenance** shall include inspecting for debris, vegetation, and sediment accumulation, flushing the underdrain, and removing or replacing media.
3. **Maintenance is required when** $\frac{1}{4}$ inch of sediment has accumulated on top of the cartridge hood, or 2 inches of sediment have accumulated on the floor. If the cartridges are in standing water more than 12 hours after rainfall has occurred, maintenance is required. The inspector should make sure that the cartridges are not submerged due to backwater conditions caused by high groundwater, plugged pipes, or high hydraulic grade lines, according to the manufacturer's recommendations.
4. **CSF (leaf compost) media** should be replaced according to the sediment recommendations above and at a minimum of every two years.
5. Media shall be disposed of in accordance with applicable regulations, including the Seattle-King County Department of Public Health solid waste regulations (Title 10) and state dangerous waste regulations (WAC 173-303). In most cases, the media may be disposed of as solid waste.

FIGURE 14-A.1.A STORMFILTER SCHEMATIC



KING COUNTY, WASHINGTON
SURFACE WATER DESIGN MANUAL

REFERENCE 14-B
KING COUNTY APPROVED PUBLIC
DOMAIN FACILITIES

None at this time

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